The I-SMART Project: Empirical Map Validation

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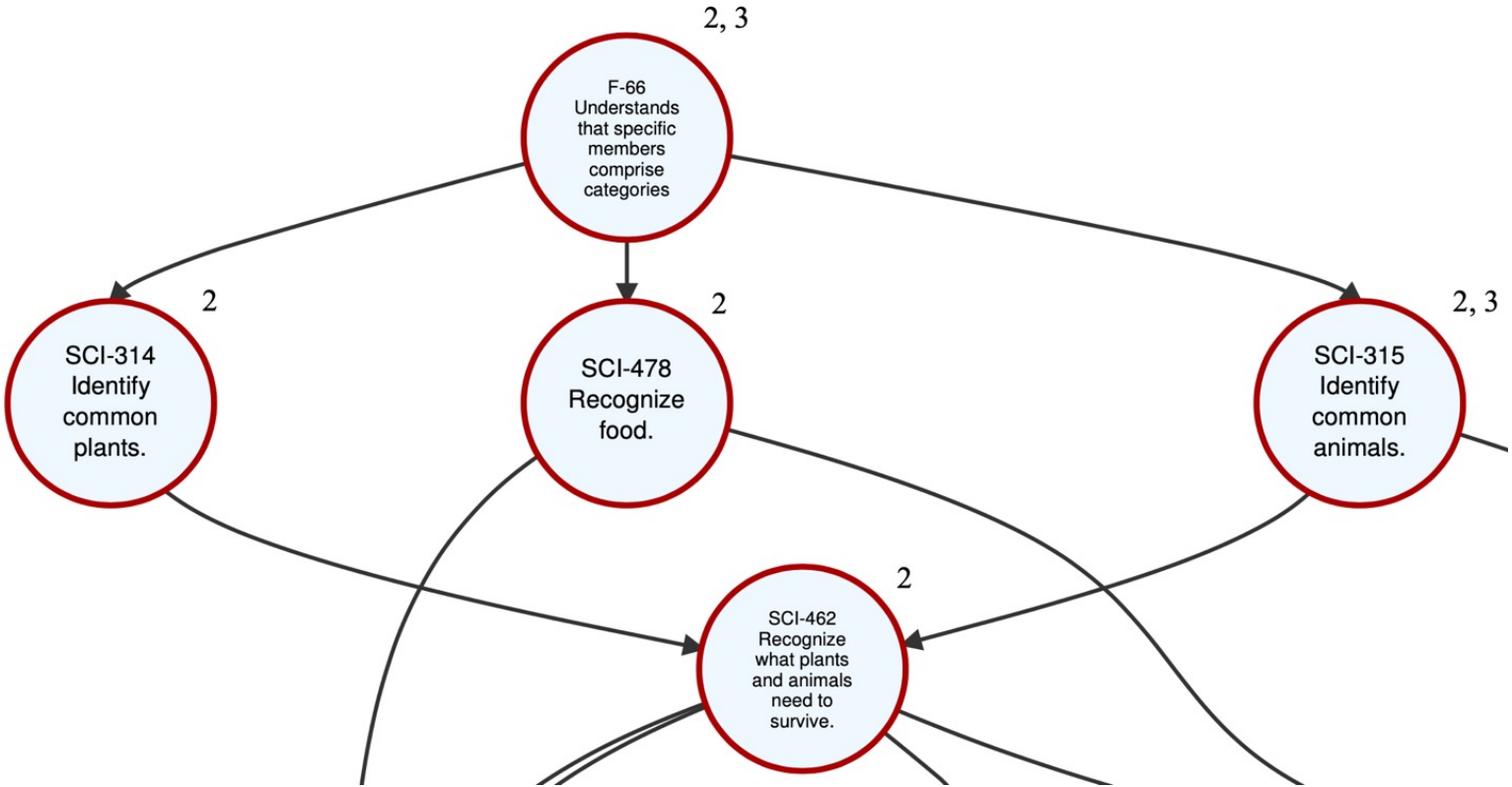
National Council on Measurement in Education

Wednesday, June 9, 2021

I-SMART Project

- Aimed to improve science achievement and progress across grades for:
  - students with significant cognitive disabilities, and
  - students with or without disabilities who are not meeting grade-level standards in science
- Developed science learning map models
- Developed maps-based assessments


2, 3
F-66
Understands that specific members comprise categories
2
SCI-314
Identify common plants.
2
SCI-478
Recognize food.
2, 3
SCI-315
Identify common animals.
2
SCI-462
Recognize what plants and animals need to survive.

Map Neighborhoods

- Essential Elements (EEs)
  - Expressed at a "Target" which most closely aligns to grade-level expectations
- Linkage levels
  - Ordered to reflect increasing complexity levels leading up to the target level EE
- Nodes
  - Knowledge, skills, and understandings within each linkage level and EE

Purpose

- Applying and expanding the DCM framework for empirically evaluating map structures
- Evaluate the evidence for the I-SMART maps
  - Do empirical data support the structure of the learning map models?

I-SMART Pilot Administration

- Piloted during the winter and fall of 2019
- 2,056 students (64% male, 36% female)
  - Grades 3-12
  - 5 participating states
- Assessed 80 nodes and 90 connections across 6 Essential Elements and 20 linkage levels

Diagnostic Assessments

- Estimates a profile of node mastery
- Supports hierarchical nodes
  - Mastering nodes may be dependent on mastery of other nodes
  - Allows for modeling a learning map structure

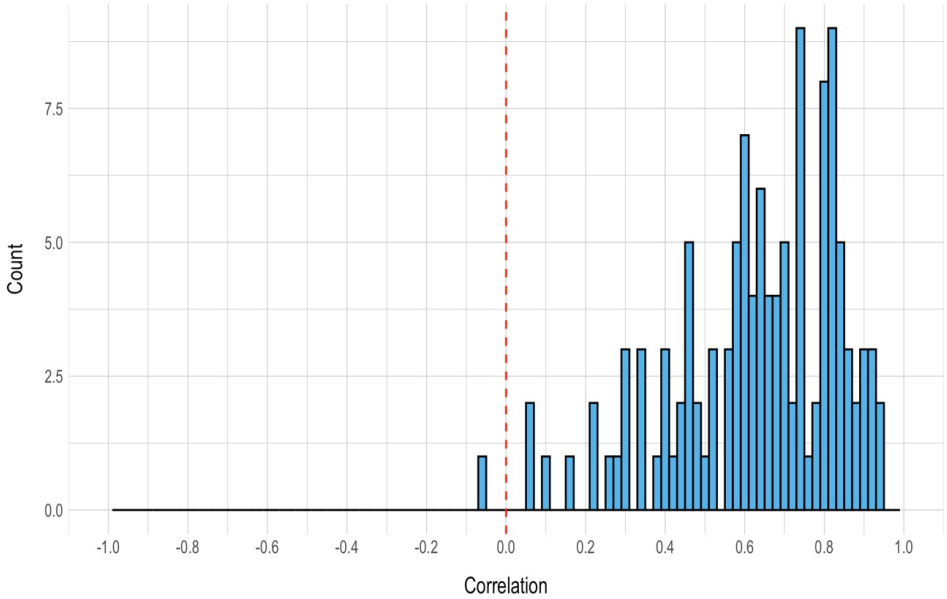
Studies

1. Node Uniqueness
2. Patterns of Mastery Profiles
3. Patterns of Mastery Assignment
4. Patterns of Node Difficulty

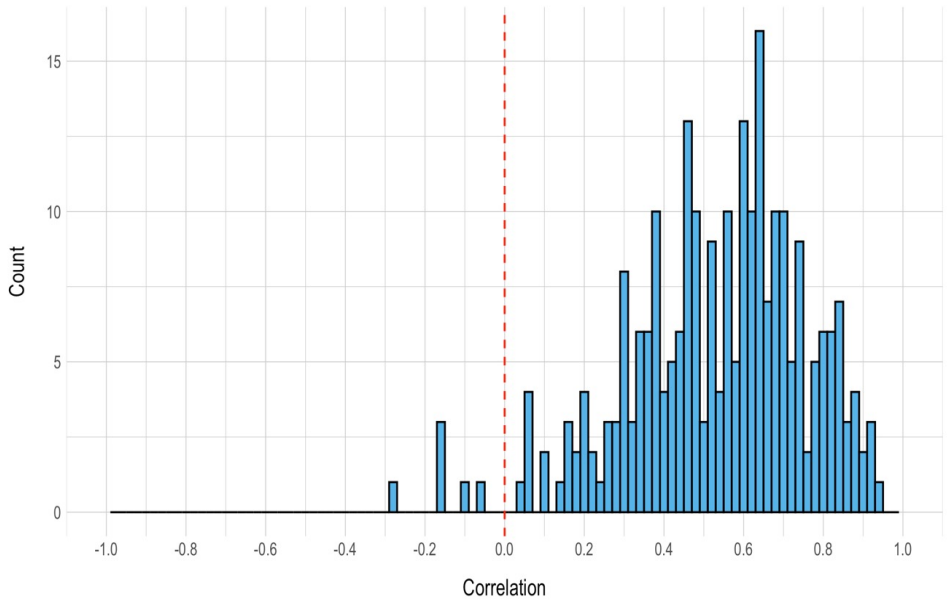
Study #1 - Node Uniqueness

- Dichotomous node mastery statuses
- Correlating node mastery
  - Within linkage level and EE
  - Within EE

Distribution of Correlations Among Node Mastery Statuses Within Linkage Level



Distribution of Correlations Among Node Mastery Statuses Within Essential Element



Study #2 - Patterns of Mastery Profiles

- Concurrently estimating two diagnostic models for each linkage level
  - Saturated and constrained models
  - If the map structure holds, we expect the constrained models to show equivalent fit to the saturated models

Patterns of Mastery Profiles Results

- Absolute model fit
  - 5 out of 20 (25%) saturated models had adequate absolute model fit
  - 6 out of 20 (30%) constrained models had adequate absolute model fit
- Relative model fit
  - Constrained models showed equivalent fit to the saturated models for all linkage levels

Study #3 - Patterns of Mastery Assignment

- Estimating single-node diagnostic models for each node within each linkage level
- Aggregating node-level mastery into a profile
  - If the map structure holds, the aggregated node mastery profiles should be consistent with the maps

Patterns of Mastery Assignment Results

Percentage of Students with an Unexpected Mastery Pattern, by Essential Element and Linkage Level

Essential Element	Initial Precursor	Distal Precursor	Proximal Precursor	Target
EE.5.LS2-1	**26.0**		**25.3**	**35.0**
EE.5.PS1-3	**27.0**		23.6	10.5
EE.MS.LS2-2	12.5		9.9	0.0
EE.MS.PS1-2	17.2		10.5	16.0
EE.HS.ESS3-3	8.5	**31.0**	**29.7**	**25.3**
EE.HS.LS2-2	13.1	0.0	4.8	**52.4**

Study #4 - Patterns of Node Difficulty

- Constructing 95% confidence intervals (CIs) for the node-level *p*-values
- Comparing the 95% CIs from adjacent nodes
  - If the map structures hold, nodes are expected to become more difficult as students progress through the maps

Patterns of Node Difficulty Results

- All connections were consistent with the defined learning map models

Applications

- Implications for I-SMART
  - Showing maps to be approximately correct
  - Informing future test development in science
  - Supporting future instructional practices
- Implications for the DCM framework
  - Demonstrating the utility of the framework
  - Illustrating the complementary strengths and weaknesses

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