Integrating Crosscutting Concepts into 3-Dimensional Scoring Rubrics

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Research Question

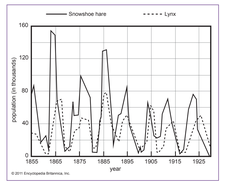
How can scoring rubrics for science performance assessments incorporate Crosscutting Concepts (CCC's) alongside disciplinary content and science practices, as described in the *Framework for K-12 Science Education and Next Generation Science Standards (NGSS)?*

Rationale

- The *Framework* and NGSS identify seven CCC's that promote coherence across K-12 science topics and disciplines
- Assessments and rubrics must address the CCCs alongside the other two performance dimensions, Disciplinary Core Ideas and Practices (NRC, 2014)
- Rubrics that foreground the CCC's can inform efforts to measure student progress across science topics and disciplines

Example 3-Dimensional Items

Hare-Lynx (life science, analyzing data)



The Canadian lynx and the snowshoe hare reside in North America's boreal forests. The graph shows the size of the snowshoe hare and lynx populations over time. Describe the relationships between the snowshoe hare and lynx populations over time.

Ice Cube (physical science, developing models)

An ice cube (solid water) in a pot is heated on a stove. In few seconds, the ice cube melts and becomes liquid water. The water then boils and leaves the pot as water vapor (gaseous water). Draw a particle model that explains how the three states of water are different.

Rubric Development Approach

1 Unpack the crosscutting concept

For the CCC patterns, we identified pattern types and constructed evidence statements

Pattern types

- Repeating occurrences (e.g. spatial, temporal)
- Similarities, differences, and classifications
- Correlations and trends

Evidence statements describing a high level of performance

- Student correctly **identifies** patterns in phenomena or data
- Student correctly **characterizes** the nature (e.g. direction, frequency) of patterns
- Student correctly **classifies** entities according to similarities and/or differences

2 Develop a construct map

Inspired partly by Lehrer's (2007) Data Display construct map, we emphasize the following distinctions:

- **Individual cases** vs. patterns based on **two or more cases**.
- **Simple patterns** (capturing a basis relationship) vs. **complex patterns** (relating simple patterns to each other or to disciplinary content)

Level	Description
Multiple and complex	Students can reason about multiple complex patterns
Multiple or complex	Students can reason about multiple simple patterns or 1 complex pattern
Simple valid	Students can reason about 1 simple pattern
Simple Invalid/Incomplete	Students can reason incompletely or invalidly about a pattern
Case	Students can discuss a single case without reasoning about a pattern
None	Students are unable discuss cases or reason about patterns

3 Identify item-specific connections across patterns, disciplinary concepts, and practices

Hare Lynx

- **Disciplinary content:** The **availability of food** for the hare and lynx and their **predator/prey relationship** determine the **population patterns** of the two species.
- **Practice: Analyzing data** involves **identifying patterns** in data.

Ice Cube

- **Disciplinary content: State changes** in matter are characterized by **patterns in the arrangement and motion of particles**.
- **Practice:** A purpose of **developing models** is to **explain patterns** in phenomena.

4 Generate a 3-dimensional rubric

	Hare-Lynx (HL)	Ice Cube (IC)
Simple patterns	• The lynx and hare population changes **coincide** • The hare population **exceeds** the lynx population • The lynx population lags the hare population	• Temperature **correlates positively** with particle spacing • Temperature **correlates positively** with particle speed
Complex patterns	• The lynx and hare population changes coincide because lynx prey on hare • The hare population exceeds the lynx population because lynx prey on hare • The lynx population lags the hare population because lynx prey on hare	• Solid and liquid particles exhibit close particle spacing, while gas particles exhibit **wide** particle spacing

Rubrics

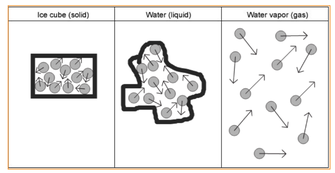
Score/Level	Hare-Lynx	Ice Cube
6: Multiple and complex	Describes at least 2 complex patterns	Illustrates the simple pattern on speed and the complex pattern on spacing
5: Multiple or Complex	Describes at least 2 simple patterns or exactly 1 complex pattern	Illustrates 2 simple patterns on speed and spacing, or 1 complex pattern on spacing
4: Simple valid	Describes exactly 1 simple pattern	Illustrates 1 simple pattern on speed or spacing across 3 states
3: Simple invalid/ incomplete	Describes lynx or hare population fluctuations without relating them to each other	Illustrates 1 simple pattern on speed or spacing across 2 states
2: Case	Describes lynx and/or hare populations only at individual time points	Illustrates particles without distinguishing states
1: None	No valid analysis of patterns or cases	Does not illustrate a particulate view

Student Work

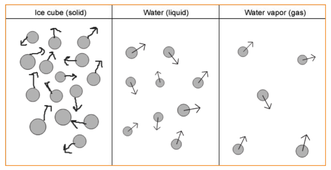
Hare-Lynx (high school)

- Level 6: "**The lynx is likely the snowshoe hare's predator**. As energy pyramids show, there are smaller populations of a predator than their prey, which accounts for why the **populations of lynx are smaller**. Also, the lynx population is dependant on the hare population since the **lynx population increases and decreases shortly after the hare population** does so."
- Level 4: "Surprisingly, the hare and the lynx's population have almost the same fluctuation. When the hare's population was at its all time peak in 1863, the lynx was at its 2nd highest peak. When the hare's population was at its lowest point in 1917, the lynx's population also plateau'd out at one of its lowest point with the period 1855-1925. **As the hare's population go up or down, the lynx's population goes up or down, respectively.**"
- Level 2: "The snowshoe hare population outnumbered the lynx population back in 1850s to the 1890s. As the lynx population remain generally the same with an average of 40,000-50,000, the snowshoe hare population increased and stays around an average of 70,000-80,000."

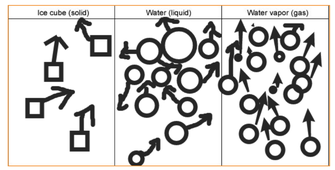
Ice Cube (middle school)



Level 6: simple pattern on particle speed and complex pattern on particle spacing



Level 4: simple pattern on particle spacing



Level 2: does not distinguish states based on particle speed or spacing

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