Research Question
How can scoring rubrics for science performance assessments incorporate Crosscutting Concepts (CCCs) 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, 2012)
- Rubrics that foreground the CCC’s can inform efforts to measure student progress across science topics and disciplines

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

2. Develop a construct map
   Inspired partly by Lehrer’s (2007) Data Display construct map, we identified pattern types and constructed evidence statements

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 determines 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
   
<table>
<thead>
<tr>
<th>Score/Level</th>
<th>Rubric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hare-Lynx (HL)</strong></td>
<td><strong>Ice Cube (IC)</strong></td>
</tr>
<tr>
<td>Simple patterns</td>
<td>Complex patterns</td>
</tr>
<tr>
<td>The lynx and hare populations changes coincide</td>
<td>The lynx and hare population changes coincide because lynx prey on hare</td>
</tr>
<tr>
<td>The hare population exceeds the lynx population</td>
<td>The lynx population lags the hare population</td>
</tr>
<tr>
<td>The lynx population lags the hare population</td>
<td>Temperature correlates positively with particle spacing</td>
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<tr>
<td>Temperature correlates positively with particle speed</td>
<td></td>
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<tr>
<td>Temperature correlates positively with particle speed</td>
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</tbody>
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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.

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 dependent 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 1983, 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 2: does not distinguish states based on particle speed or spacing