Defining and Measuring Leadership Content Knowledge for Science Practices (LCK-SP)
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INSTRUCTIONAL LEADERSHIP FOR SCIENCE PRACTICES
- Instructional leaders will need to support teachers in shifting their instruction to include the 8 NGSS science practices (Reiser, 2013).
- Leadership Content Knowledge (LCK) is a type of knowledge instructional leaders use as they design professional development, make curricular decisions, and support adult learning (Stein & Nelson, 2003).
- We currently lack instruments to measure or characterize instructional leaders' LCK for science practices, even though this type of knowledge is crucial to their supervision of teachers (Stein & Nelson, 2003).
- We view LCK for science practices as incorporating two aspects: (1) Leaders' abilities to notice aspects of classroom practice and interpret them in meaningful ways (Sherin & van Es, 2005); and (2) Leaders' abilities to provide teachers with constructive feedback about their instruction of science practices.

METHODS
- We adapted the process used by Hill and her colleagues (2004; 2008) to develop this instrument: conceptualization of the domain, design of items, pilot testing and advisor feedback, cognitive interviews, and revision of items.

Step 1: Conceptualization of the Domain
- We designed a continuum that represents increasing proficiency in practice-based instruction.

Figure 1. Supervision Continuum for Developing and Using Models

Level 1: Teacher does not provide opportunities for students to use or create models.
Level 2: Teacher provides opportunities for students to create or use models. Students' models focus on describing natural phenomena rather than predicting or explaining the natural world. Students do not evaluate the merits and limitations of the models.
Level 3: Teacher provides opportunities for students to create or use models focused on predicting or explaining the natural world. Students do not evaluate the merits and limitations of the model.
Level 4: Teacher provides opportunities for students to create or use models focused on predicting or explaining the natural world. Students do evaluate the merits and limitations of the model.

Step 2: Design of Items
We used the continuum to develop vignettes that demonstrated stronger (Levels 3 and 4) and weaker (Level 2) instruction of science practices.

Figure 2. Vignette of Instruction

Ms. Wilson: Now that we have talked about the data you gathered in our “water cycle in a bag” experiment, I want to tell you our next project. You will be working in small groups, designing and creating visual representations of the components of the water cycle. Let’s remind ourselves about the words scientists use for the parts of the water cycle so you can use them in your models. James, do you want to start?

James: The water we put in the bag evaporated.

Ms. Wilson: Good, James. I’ll write “evaporated” up here on the board so everyone will know how to spell it. What else?

Michelle: The evaporated water turned back into regular water. Is that condensation?

Ms. Wilson: Good question, Michelle. That’s right, condensation.

Debbie: What was it called when the water dripped down the inside of the bag?

Ms. Wilson: Who can help Debbie out?

Brian: Precipitation, right?

Ms. Wilson: Good, Brian. So we’ve got those three parts of the water cycle. Evaporation, condensation, and precipitation. Now, everyone is going to draw what he or she saw in our “water cycle in a bag.” The students make their drawings.

Ms. Wilson: Great drawings, everyone. You all created wonderful models of the water cycle.

Step 3: Pilot Testing and Advisor Feedback
- We piloted the instrument with 44 principals and assistant principals.
- We also asked for feedback from our advisors about how well the items aligned with the key features of the science practice.
- The distribution of principals’ and advisors’ choices for the question in Figure 3 are shown below in Table 1.

Table 1: Distribution of Responses to Sample Multiple Choice Item
<table>
<thead>
<tr>
<th>Choice</th>
<th>Principals Surveyed (n=44)</th>
<th>Principals Interviewed (n=5)</th>
<th>Advisors (n=5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>7</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>b.</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>c.</td>
<td>20</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>d.</td>
<td>13</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Step 4: Cognitive Interviews
- We conducted cognitive interviews with 5 principals who completed the survey.
- Principals were asked “why do you think your science practice was rated at Level 2?”
- Principal 04 was the only participant to select the correct answer, a target leader’s knowledge of the quality of instruction that they noticed and appropriate feedback to provide teachers.

Figure 3: Sample Multiple Choice Item: Developing and Using Models

What feedback should Dr. Martinez provide to Ms. Wilson related to her instruction around the science practice of developing and using models?

a. A graphic organizer might be a helpful scaffold to support students in their learning of the water cycle.

b. Your students probably need chances to read more about evaporation and condensation for their models.

c. You should help students see the difference between a model and just drawing observations.

d. Creating an essential question to frame the learning about the water cycle could be a good idea.

Step 5: Revision of Items
- Based on the pilot testing, advisor feedback and cognitive interviews, we revised the vignette and items.

IMPLICATIONS
- We currently lack instruments to measure or characterize instructional leaders' LCK for science practices, even though this type of knowledge is crucial to their supervision of teachers (Stein & Nelson, 2003).
- Principals displayed a range of LCK for science practices, but many were challenged to notice and provide feedback about specific science practices.
- Districts are most effective when they focus on general elements of instruction that principals prioritize, such as student engagement and lesson objectives.
- Question stems may be more useful when phrased as questions, as principals often ask questions in providing feedback to teachers.
- Additional research in this area is necessary as instructional leadership for science practices will be essential to the successful implementation of the NGSS (Reiser, 2013; NRC, 2015).
- We are creating additional resources for instructional leaders: www.sciencepracticesleadership.com

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