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 Model

←Instructional Proficiency←	
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 model.
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 to make your own models 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.

- For each vignette we designed four multiple choice and one open-ended item. These items targeted leaders' 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.[1]
d. Creating an essential question to frame the learning about the water cycle could be a good idea.

[1]Correct answer

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 practices.
- 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

Choice	Principals Surveyed (n=44)	Principals Interviewed (n=5)	Advisors (n=5)
a. A graphic organizer might be a helpful scaffold to support students in their learning of the water cycle.	7	1	0
b. Your students probably need chances to read more about evaporation and condensation for their models.	3	1	0
c. You should help students see the difference between a model and just drawing observations.	20	1	4
d. Creating an essential question to frame the learning about the water cycle could be a good idea.	13	2	1

- Table 1 indicates that fewer than half of the leaders selected the correct choice, c.
- The results also suggest that choices a and b are not as appealing distractors as choice d.
- Our advisors also provided feedback about how well the items in our instrument aligned with the key features of the focal science practice.
  - All the advisors agreed that the way Ms. Wilson discussed models does not align with the goals of the NGSS science practice of "Developing and Using Models."
  - The advisor who selected an incorrect answer, d, interpreted this distractor as relating to modeling: *"Would having an essential question mean that students are now applying what they learned in the bag to draw a model answering the question? Would it mean that students would be making models that they can use to answer the question?"*

Step 4: Cognitive Interviews

- We conducted cognitive interviews with 5 principals who completed the survey.
- Principals were asked to "think aloud" as they answered the questions.
- Principal 04 was the only participant to select the correct answer, a, for the vignette in Figure 1. Her response indicated that she noticed students were not constructing scientific models: *"...did they just draw the bags with water again, or did they actually create a model representing the different phases of the water cycle?"*
- Principal 18 selected choice d, suggesting that she did not notice that Ms. Wilson did not engage students in creating scientific models: *"I think that they're all probably good things to do, but I really like the question, d. I really like putting things in a context that kids know why you're doing it, why it's important."*

Step 5: Revision of Items

- Based on the pilot testing, advisor feedback and cognitive interviews, we revised the vignette and items.

We changed the stem of the question because principals indicated that they often frame their feedback as a question.

Since few principals selected choices a or b in the pilot testing, we created new distractors to reflect elements of instruction on which the principals we interviewed stated they typically focus: lesson objectives and supporting diverse learners.

What question should Dr. Martinez ask Ms. Wilson to focus her reflection on the science practice of developing and using models?

a. How does this modeling activity support your lesson objective related to the water cycle?
b. What type of visual representation of the key science terms could you add to this lesson?
c. Can you talk to me a little about how a model is different than just drawing observations?
d. What could you do to enable more students to participate in the discussion about models?

One of our advisors suggested that we should focus the correct answer on whether the teacher understands what counts as a model, so we revised choice c.

Based on the feedback of one of our advisors, we changed choice d to focus on another element of instruction on which principals typically focus: student engagement.

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.
- Distractors 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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