Assessing Pedagogical Content Knowledge for Data Fluency for Middle School STEM Teachers

(Work in Progress, do not distribute without permission from the authors)

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Abstract

This work-in-progress paper describes the development of an assessment for teachers' pedagogical content knowledge (PCK) for data fluency – the ability and confidence to actively make sense of and use data. In the context of a project that seeks to develop and pilot test data fluency professional learning for mathematics and science teachers in grades 6–9, researchers constructed a novel instrument for assessing teachers' specialized knowledge for teaching, which lives at the intersection of data knowledge, domain-specific knowledge, pedagogy, and technology. This online one-hour instrument is a written performance task and is sensitive to three dimensions of PCK: 1) teachers' ability to analyze student thinking, 2) teachers' ability to plan instruction, and 3) the degree to which teachers' responses reflect a learner-centered orientation. The project team is currently developing a scoring rubric for this instrument, which will be revised based on the pretest and posttest data from the pilot study.

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Subject

In today's rapidly advancing world, data is increasingly crucial in shaping our understanding of the world. The importance of data highlights the necessity of integrating data literacy into K–12 education to equip students with the skills required to navigate the data-driven world. Over a decade ago, the Framework for K–12 Science Education (National Research Council, 2012) was published, highlighting the importance of mathematics and data analysis. The Pre-K–12 Guidelines for Assessment and Instruction in Statistics Education II (GAISE II) recommends promoting data literacy (Bargagliotti et al., 2020). These guidelines aim to help students develop confidence in their statistical reasoning abilities when interpreting data while encouraging a healthy level of skepticism when analyzing data (Franklin & Bargagliotti, 2020).

In this project, we define *data fluency* as the ability and confidence to actively *make sense of and use data.* This concept extends beyond possessing discrete knowledge and skills (for example, creating graphs). It is knowing when, how, and why to use data to explore topics of interest and for a specific purpose such as solving problems, understanding phenomena, and communicating ideas grounded in evidence. This understanding of data fluency emphasizes the strong link between data fluency and the specific subject matter to which it is applied. The interdisciplinary nature of data fluency means that we need instruments that adequately account for the data-related knowledge *and* the subject-specific knowledge involved in working with data.

The interdisciplinary nature of data fluency instruction presents a research gap in effectively assessing and developing teachers' pedagogical content knowledge (PCK). Earlier measures of statistical understanding, such as LOCUS (Levels of Conceptual Understanding in Statistics) (Jacobbe et al., 2014), have typically focused on assessing specific statistical skills with a narrow grounding in a data context. Examining this gap, Miller (2022) used teacher interviews to assess data-related PCK in the context of the data that were used. This paper describes a new, *written* PCK assessment for data fluency that can be used with larger groups of teachers where individual interviews may not be feasible.

Study Context

The Boosting Data Science Teaching and Learning in STEM (aka Data Fluency Project)[1] aims to develop professional learning for science and math educators in grades 6–9. The professional learning is intended to support educators' content knowledge and pedagogical content knowledge related to data-rich instruction through participation in a summer institute, school-year community practice meetings, and classroom resources such as access to datasets that could be used with students. This paper describes the development of a pedagogical content knowledge assessment for use in a pilot study of the professional learning course *Data Fluency: Making Sense of Data in STEM*.

Theoretical Frameworks

Data Fluency Project Logic Model

The Data Fluency Project logic model (Figure 1) describes key aspects of the professional learning (PL) features and anticipated teacher, classroom, and student outcomes (Wong et al., 2024). It also signals the importance of the school and district context. The logic model was informed by standards documents such as the NGSS, Common Core Math, Common Core Literacy in Science, GAISE, and the K-12 Computer Science Framework, primarily focusing on areas relevant to grades 6–9 (National Research Council, 2012; GAISE II; Franklin & Bargagliotti, 2020).

The descriptors of teacher and student knowledge signify a deliberate integration of multiple disciplines within data education in STEM, encompassing domain knowledge, data knowledge, technological knowledge, statistical knowledge, and sociocultural and affective aspects of working with data.

The classroom outcomes reflect our belief that classroom communities can vary in the degree to which they provide opportunities for students to engage with data and foster classroom cultures that support sensemaking with data.

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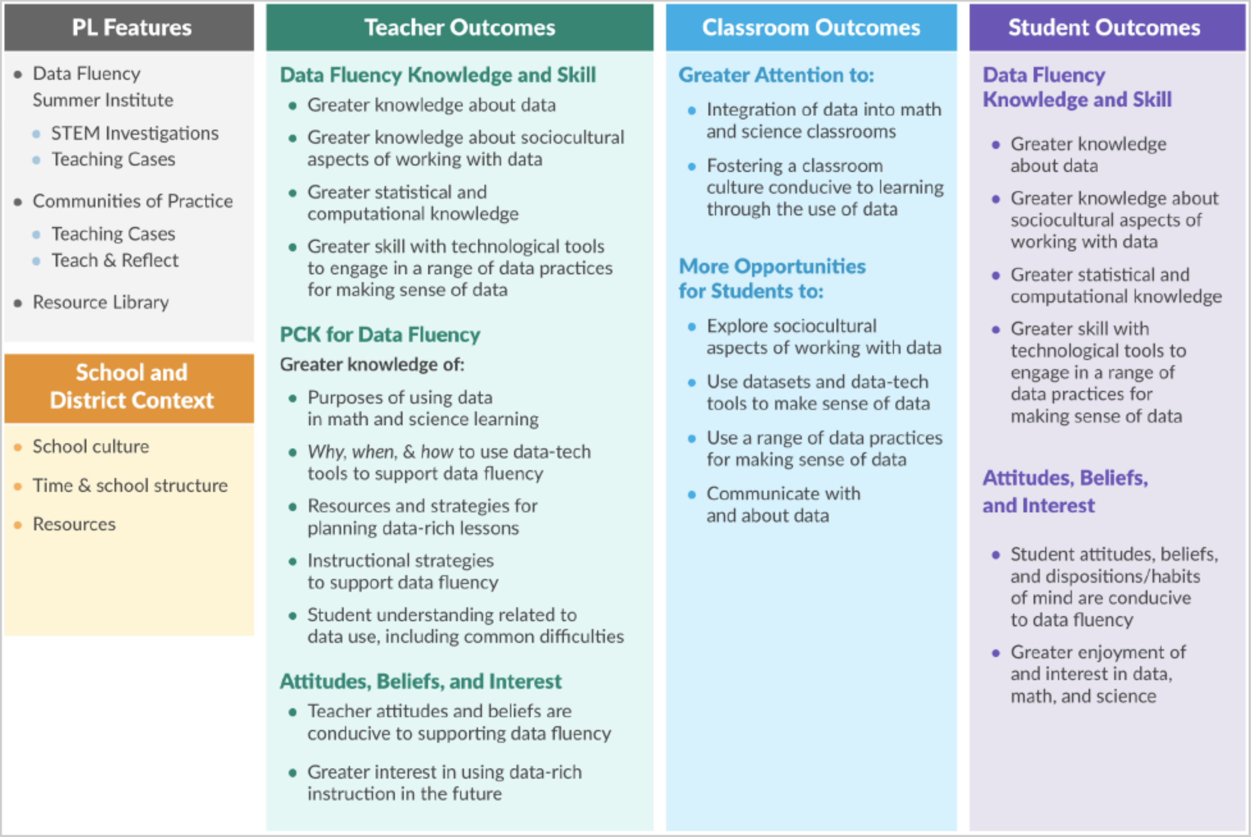
We categorize teacher outcomes into three interrelated domains: a) teachers' own data fluency knowledge and skill, which includes statistical knowledge and technology; b) teachers' pedagogical content knowledge for data fluency; and c) teachers' attitudes and beliefs related to data-rich instruction.

Figure 1.

Data Fluency Project Logic Model



PL Features

- Data Fluency Summer Institute
  - STEM Investigations
  - Teaching Cases
- Communities of Practice
  - Teaching Cases
  - Teach & Reflect
- Resource Library

School and District Context

- School culture
- Time & school structure
- Resources

Teacher Outcomes

Data Fluency Knowledge and Skill

- Greater knowledge about data
- Greater knowledge about sociocultural aspects of working with data
- Greater statistical and computational knowledge
- Greater skill with technological tools to engage in a range of data practices for making sense of data

PCK for Data Fluency

Greater knowledge of:

- Purposes of using data in math and science learning
- *Why, when,* & *how* to use data-tech tools to support data fluency
- Resources and strategies for planning data-rich lessons
- Instructional strategies to support data fluency
- Student understanding related to data use, including common difficulties

Attitudes, Beliefs, and Interest

- Teacher attitudes and beliefs are conducive to supporting data fluency
- Greater interest in using data-rich instruction in the future

Classroom Outcomes

Greater Attention to:

- Integration of data into math and science classrooms
- Fostering a classroom culture conducive to learning through the use of data

More Opportunities for Students to:

- Explore sociocultural aspects of working with data
- Use datasets and data-tech tools to make sense of data
- Use a range of data practices for making sense of data
- Communicate with and about data

Student Outcomes

Data Fluency Knowledge and Skill

- Greater knowledge about data
- Greater knowledge about sociocultural aspects of working with data
- Greater statistical and computational knowledge
- Greater skill with technological tools to engage in a range of data practices for making sense of data

Attitudes, Beliefs, and Interest

- Student attitudes, beliefs, and dispositions/habits of mind are conducive to data fluency
- Greater enjoyment of and interest in data, math, and science

Our conceptualization of PCK for data fluency in this project is informed by three models: The Refined Consensus Model (RCM) of PCK by Carlson et al. (2019), the Technological Pedagogical Content Knowledge (TPACK) framework by Mishra and Koehler (2006), and the Technological Pedagogical Statistical Knowledge for Teachers of Statistics by Lee and Hollebrands (2011).

Pedagogical Content Knowledge

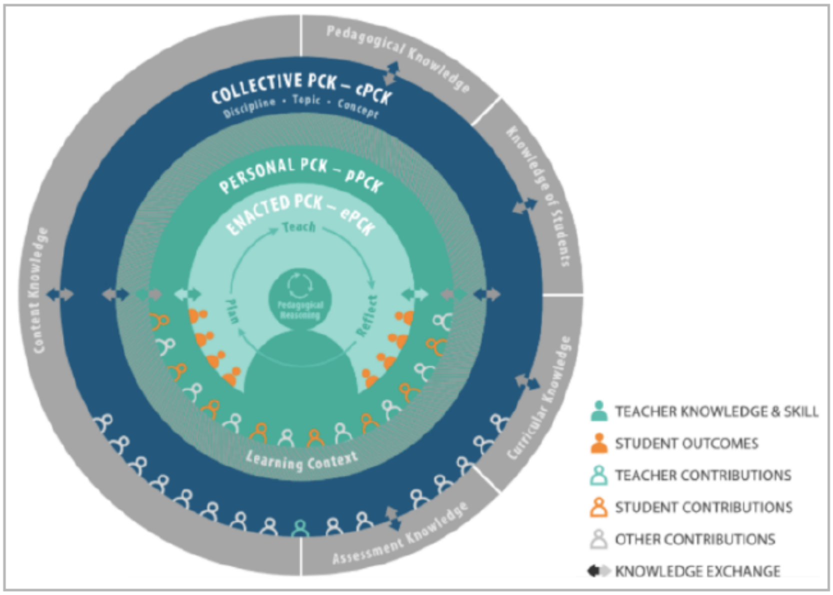
The Refined Consensus Model of PCK

Research on teacher preparation for STEM has focused on supporting the development of pedagogical content knowledge (PCK), which describes the specialized knowledge teachers possess at the intersection of pedagogy and content knowledge (Shulman, 1986). The models of PCK that follow are built from this original conceptualization.

The RCM of PCK in science education by Carlson et al. (2019) delineates three levels of PCK (collective, personal, and enacted) and describes the interconnected relationships and flow of knowledge between them (Figure 1). The RCM first distinguishes between personal and enacted PCK, clarifying that personal PCK represents a teacher's knowledge about teaching a specific topic in a given context. Enacted PCK, on the other hand, is the application of this knowledge during the teaching of actual lessons, with both levels (personal and enacted) influencing each other. Collective PCK articulates the knowledge teachers actively draw from professional knowledge bases, such as their knowledge of content, pedagogy, students, the curriculum, and assessment, as they enact this PCK. This model also indicates that the learning context influences teaching and learning. The PCK assessment developed for this project and discussed in this paper attempts to elicit responses about what teachers might do as they plan, teach, and reflect on instruction. Thus, we hypothesize that insights into a teacher's enacted PCK can be gained.

Figure 2.

The Refined Consensus Model of Pedagogical Content Knowledge in Science Education



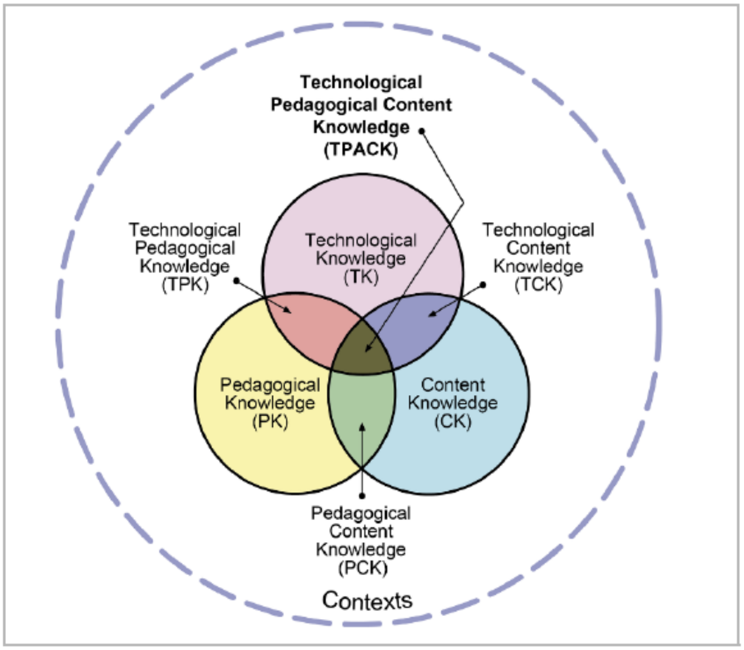
Note: This image is from Carlson *et al.* (2019). The Refined Consensus Model of Pedagogical Content Knowledge in Science Education (p. 83). In: Hume, A., Cooper, R., Borowski, A. (eds) *Repositioning Pedagogical Content Knowledge in Teachers' Knowledge for Teaching Science*. Springer, Singapore. https://doi.org/10.1007/978-981-13-5898-2_2

The TPACK Framework

While the RCM offers a robust theoretical foundation for PCK in science, our project needed a model to address the technological and statistical PCK required to teach data fluency. For the role of technology, we draw on the Technological Pedagogical and Content Knowledge (TPACK) framework by Mishra and Koehler (2006) to understand the teacher knowledge required for effective technology integration, which acknowledges teachers' knowledge of the dynamic interplay among the three foundational knowledge types: content knowledge, pedagogical knowledge, and technological knowledge (Figure 3).

Figure 3.

The Technological Pedagogical Content Knowledge Framework



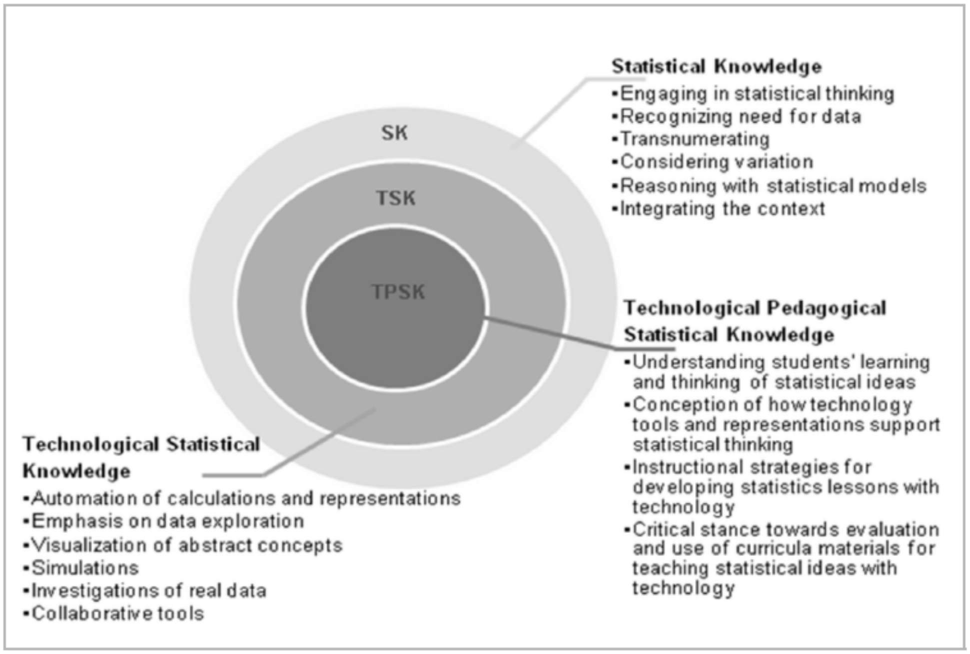
Note: This diagram is from Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. *Teachers College Record*, 108(6), 1017–1054.

Components of Technological Pedagogical Statistical Knowledge

Lastly, we draw on the work of Lee and Hollebrands (2011), who articulate the essential knowledge bases for teaching statistics using technology. This framework comprises three components: Statistical Knowledge (SK), Technological Statistical Knowledge (TSK), and Technological Pedagogical Statistical Knowledge (TPSK). We selected this framework because of the explicit focus on the TPSK knowledge base which taps into a teacher's understanding of students' thinking of statistical ideas and their knowledge of instructional strategies for developing data-rich lessons with technology.

Figure 4.

Components of Technological Pedagogical Statistical Knowledge



Note: Diagram from Lee, H. S., & Hollebrands, K. F. (2011). Characterising and developing teachers' knowledge for teaching statistics with technology. *Teaching statistics in school mathematics-challenges for teaching and teacher education: A joint ICMI/IASE study: The 18th ICMI study*, 359–369.

About the Assessment

The PCK assessment was designed as a written performance task for Math and Science teachers of grades 6–9 attending a pilot study of the professional learning course *Data Fluency: Making Sense of Data in STEM*. In June 2023, 12 educators taking the course were asked to complete the 60-minute online assessment as a pretest immediately before starting a 3-day summer institute. In April 2024, after their experiences in the summer institute and a series of four school-year community of practice meetings, these educators will complete an identical task as a posttest.

Table 1 shows the blueprint that guided our construction of the assessment.

Table 1.

Assessment Blueprint

Component	Description
Format	Online, written performance task
Length	60 minutes
Target Audience	Mathematics and science teachers of students in grades 6–9
Primary Assessment Domains (PCK intentionally elicited as a primary focus of the assessment)	Educators' knowledge about • The purposes of using data in math and science learning • Resources and strategies for planning data-rich lessons • Instructional strategies to support data fluency • Student understanding related to data use, including common difficulties
Secondary Assessment Domains (Other forms of teacher knowledge elicited by the questions)	Educators' own • Knowledge about data • Knowledge about sociocultural aspects of working with data, including the importance of data-friendly habits of mind • Statistical and computational knowledge Educators' attitudes and beliefs, including student-centered orientation to teaching and learning
Data, Math, & Science Context	• 7th grade life science with earlier grade content standards related to the biological variation of traits (ladybugs) • Measures of central tendency • Statistical variability
Qualities of the Scenario	Provides opportunities for teachers to examine • The fictitious teacher's learning goals for her students • The dataset that students used • Students' discourse • Students' representations Includes opportunities for respondents to make observations about • Students' data practices across many phases of a data investigative process (e.g., evaluating data, posing questions, representing data, interpreting data, making claims) • Students' data habits of mind (e.g., curiosity, openness, propensity to seek deeper meaning) • Students' ideas, including both productive or correct understanding and less productive or incorrect understanding

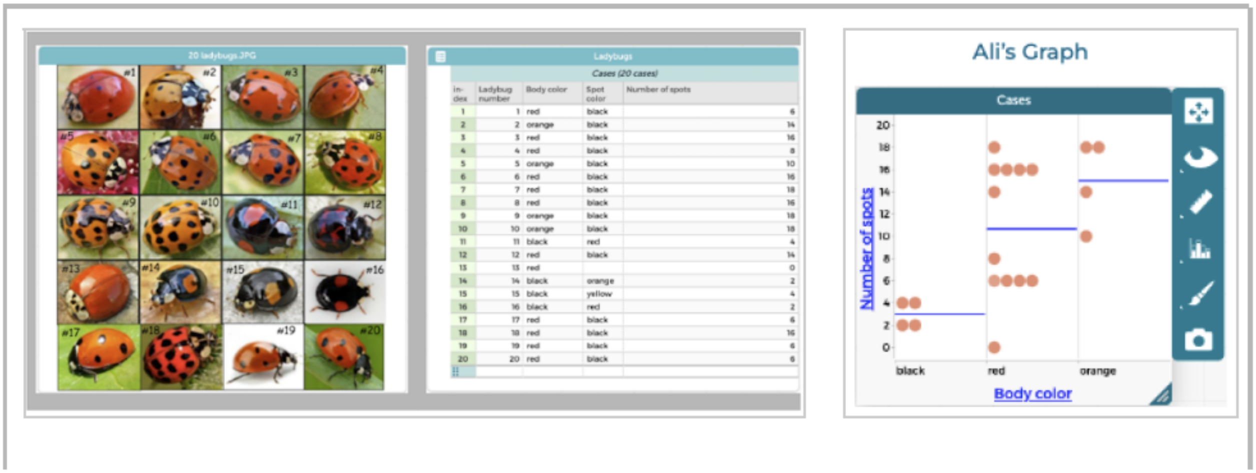
The PCK assessment is a performance task that mirrors the format of a Making Sense of SCIENCE teaching case. Teaching cases are an essential tool in this project's Making Sense of SCIENCE professional learning model.[2] Teaching cases are narrative stories of teachers sharing what happens in their classroom. They are used in the PL to help educators critically examine what might happen in a real classroom, engage in evidence-based discussions about student thinking, and consider the tradeoffs of various instructional choices. While the PCK assessment does not replicate a complete teaching case, it utilizes some of its key attributes. By asking teachers to engage in practices similar to those they would use in their own instruction, such as analyzing student thinking and planning instruction, the assessment elicits teachers' enacted PCK (Carlson et al., 2019).

In the assessment, teachers read a fictitious narrative about what happens in Ms. Humphrey's 7th grade biology class. The narrative describes Ms. Humphrey's goals for her students, a progression of lesson activities, the dataset students used, graphs created by two students (Ali and Amari), and snippets of student dialogue (Figure 5).

We carefully constructed the narrative to surface numerous data practices, data-friendly habits of mind, and students' understanding and common difficulties related to the biological variation of traits, statistical variability, and understanding of the mean.

Figure 5.

Screenshots of the PCK assessment depicting the ladybug dataset that Ms. Humphrey used with her students, a student-generated graph, and text from a student discussion



Ladybugs

Cases (20 cases)

index	Ladybug number	Body color	Spot color	Number of spots
1	1	red	black	6
2	2	orange	black	14
3	3	red	black	16
4	4	red	black	8
5	5	orange	black	10
6	6	red	black	16
7	7	red	black	18
8	8	red	black	16
9	9	orange	black	18
10	10	orange	black	18
11	11	black	red	4
12	12	red	black	14
13	13	red		0
14	14	black	orange	2
15	15	black	yellow	4
16	16	black	red	2
17	17	red	black	6
18	18	red	black	16
19	19	red	black	6
20	20	red	black	6

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[2] The Data Fluency project developed a new professional learning course that follows the Making Sense of SCIENCE approach. Making Sense of SCIENCE offers a well-established model for teacher professional learning that has a proven track record of strengthening teacher knowledge, transforming classroom practices (Little et al., 2018).

Ali: I started with the same graph as you, and then I added lines to show where the mean is for each group – black, red, or orange. The mean is the average number of spots for each group. The line for the orange ones is at 15, and the other two are lower. The reds are at 10, and the black ones aren't even close. That means the orange ones have more spots.

Amari: That blue line doesn't make sense. There aren't any ladybugs in the photos with 15 spots. Kai said their wings are mirror images, so it has to be an even number. I don't understand what the blue line means.

Throughout the narrative, participants are asked to respond to the questions such as:

1. What knowledge or skills do these students seem to show related to using data?
2. What are some points of confusion or opportunities for further learning?
3. Imagine that you are Amari and Ali's teacher. What could you do to help them strengthen their understanding?
4. How would you modify Ms. Humphrey's goals to meet the needs of your class or classes?

These questions ask teachers to describe students' strengths, identify points of student confusion, suggest instructional next steps for the students, and imagine what similar instruction might look like in their own contexts. These questions were designed to evaluate the primary assessment domains shown in Table 1: teachers' knowledge of the purposes of using data in math and science learning (i.e., what is important for students to know?), resources and strategies for planning data-rich lessons, instructional strategies to support data fluency, and student understanding related to data use, including familiarity with common student difficulties.

We believe that teachers' ability to engage in these tasks was also tightly coupled with their data science content knowledge, domain-specific content knowledge (e.g., science, mathematics, or technology), and statistical and computational knowledge and thinking. These other forms of knowledge correspond with the "secondary assessment domains" and the "data, math, and science context" listed in Table 1.

We aimed to construct an assessment that accounts for the interdisciplinary nature of data fluency, and we believe that we have created an instrument that elicits teacher knowledge at the intersection of data, pedagogy, and domain knowledge. However, it was not feasible to include all aspects of teacher knowledge in our project logic model for this 60-minute assessment. For example, we chose not to focus on teachers' technological pedagogical content knowledge or their knowledge-related students' ability to pose investigable questions. However, we are open to extending this assessment to these knowledge bases.

Codebook & Scoring Rubric Development

We are currently engaged in the process of developing our codebook and scoring rubric, using our pilot study teachers' pretests as a guide. After we collect the posttests, we will refine these guides using the new information, score all of the assessments, and look for any potential changes in scores from pre to post.

The sections that follow describe our first major round of codebook and scoring rubric development.

Initial Coding

We reviewed the teachers' responses to identify the conceptual knowledge and PCK reflected in the answers. First, we read through the entire set of the teachers' responses to immerse ourselves in the range of responses that the prompts elicited. We noted that, even upon this first read, the questions elicited a range of responses related to teacher pedagogical content knowledge. Figure 6 provides two sets of contrasting examples to illustrate this range.

Figure 6.

Analytic memo with observations from an informal reading of teacher responses

Question prompt: Based on the discussion of Ali's graph, what knowledge, skills, or habits of mind do Ali and Amari seem to have related to using data?

Teacher 1: They are using skepticism, using logic. They are open to discussing differences in thinking and asking questions. Amari is overly focused on individual data points and not on trends or patterns across the data. Ali knows he is onto something but he isn't confident in his understanding. . . .They need more help and work on understanding mean/averages and what it can tell us about a group of individuals.

Teacher 2: They may know what 'mean' means, but the way they used it on the graph is wrong.

Teacher 1's response covered a wide range of data-related topics and skills and had a high degree of conceptual depth. With regard to *data content understanding*, Teacher 1 points out the limitation of Amari's approach of focusing on individual data points. This observation suggests an understanding of the significance of seeing patterns. With regard to *data-related habits of mind,* Teacher 1 recognized that the students exhibited skepticism, logical reasoning, openness to discussing differences, and willingness to ask questions, which shows that she understands the value of data-fluent habits of mind. In terms of *future instruction*, Teacher 1 specifically named the student's difficulty with the concept of *mean* and its implications for interpreting data about a group. This acknowledgment shows an awareness of a mathematical and statistical concept and its importance in building a strong understanding of the data.

Teacher 2's response is more limited: She suggests an error in the student's application of the concept of "mean" in relation to the graph. However, it is difficult to understand what the teacher perceives as a misconception or why the application on the graph is incorrect. The latter point on the application of the mean on the graph may even point to a potential misconception on the part of the teacher. However, it is difficult to be sure without further elaboration from the teacher.

> **Question Prompt:** Imagine that you are Amari and Ali's teacher. What could you do to help them strengthen their understanding?
>
> **Teacher 3:** I would introduce them to finding the range and possibly the mean absolute deviation. This would give an even clearer picture of how accurate the mean truly is.
>
> **Teacher 4:** Look at the data set–How would you better answer your question? What makes sense? Use another example to clarify?

Teacher 3's response identifies instructional activities specific to supporting data understanding: she suggests engaging students in finding the range and mean absolute deviation. She explains that these activities might help students better understand the mean. In contrast, Teacher 4's lower-level response identifies pedagogical practices that have general value but are not specific to data.

On the basis of these initial readings, we selected for coding a handful of assessments that seemed to reflect different strengths. The primary goals of this initial coding were to 1) check to see whether our prompts were successful in eliciting the aspects of teacher knowledge that we hoped; 2) refine our codebook by contributing new codes, clarifying definitions, and providing examples; and 3) see if we could begin to detect variation among the responses on the basis of the codes we used.

The unit of analysis was the entire assessment – all 11 items. We coded individual questions first, then we synthesized our coding to check for internal consistency of emerging themes across questions. The codes we used corresponded with the assessment domains described in our blueprint (Table 1), which represents a subset of the teacher knowledge articulated in our project logic model (Figure 1).

Two researchers independently applied codes and annotations to the teachers' responses, and then we held discussions to clarify our understanding of the codes, discuss emerging themes, and revise our codebook and analytic memos. The annotations helped us articulate the rationale for and nuances about the codes we were applying. These notes helped us move from individual codes to a scoring rubric.

> *This part, alone, is quite strong because of how cohesive it is – name the problem, say what's wrong with it, identify an instructional next step. The problem and the response are very specific to these specific students' statistical reasoning. In this case, she refocuses student attention to the means in order to encourage them to think about the aggregate. Using measures of center are a grade-appropriate standard.*
>
> ***Note that this instructional suggestion doesn't quite get at integrating the concept of variability (also appropriate for 7th grade), but that's okay – that may or may not be coming in a future step. In scoring this, we are simply giving credit for what is there.*
>
> — Researcher annotation on one teacher's response

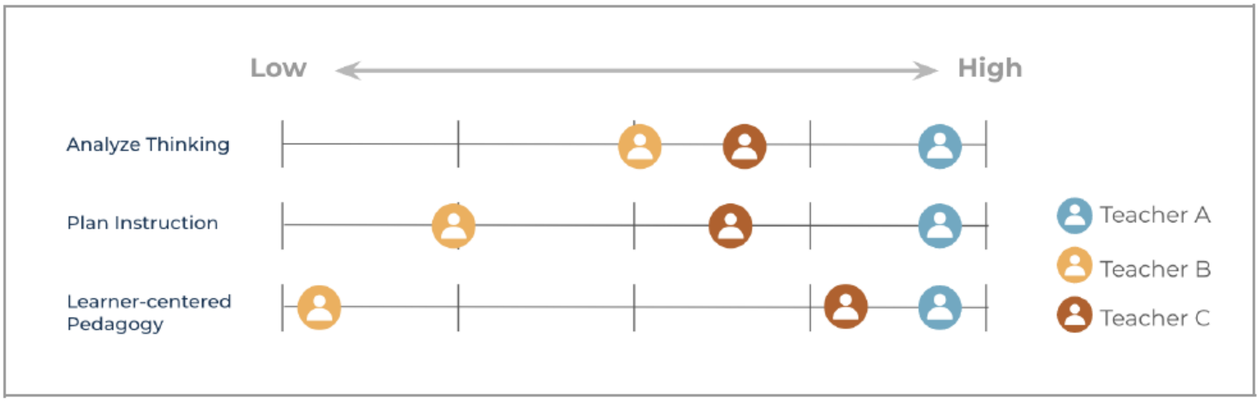
Scoring Rubric: Dimensions of PCK

The initial coding helped us become attuned to sources of variation among the responses and served as the basis for our articulation of three dimensions of PCK: 1) teachers' ability to analyze student thinking, 2) teachers' ability to plan instruction, and 3) the degree to which the teachers' responses reflect a learner-centered orientation. These dimensions will become the foundation for a rubric for scoring teacher responses.

After collecting the posttest and completing the rubric, we intend to rate teachers' responses along each of the dimensions (Figure 7). We are actively considering the utility of combining the scores into a single PCK score. We will need to consider whether and in what ways that information is useful, as well as the methods for combining those scores.

Figure 7.

Dimensions of PCK for Data Fluency



The scoring rubric is incomplete, but we have begun describing the dimension and characterizing what might constitute higher-rated responses within that dimension. These descriptions were created based on data from the pretest, and we will continue to refine this work after we collect the posttest.

Dimension 1: Analyze Student Thinking

Dimension 1 assesses teachers' ability to use evidence of student thinking, such as dialogue and student-constructed data representations, to evaluate students' data-related knowledge, skills, and habits of mind as well as relevant science and math content knowledge, skills, and habits of mind.

In order to analyze student thinking, teachers need to

- possess a robust understanding of the data, math, and science knowledge, skills, and habits of mind elicited by the classroom data tasks in the assessment (this is a reflection of teachers' *own* data fluency knowledge and skill)
- be aware of the relevant knowledge, skills, and habits of mind for data fluency in mathematics and science at their students' grade level
- anticipate the common yet incorrect ideas or areas of difficulty related to data, math, or science that could be elicited by the classroom task(s) in the assessment
- use evidence of student thinking to understand where students might fit on a continuum of progress toward more productive or robust data knowledge, skills, and habits of mind
- recognize when more information about students' thinking might be needed to assess their current knowledge and abilities

Most of the codes relevant to this dimension came from responses to the items that asked: *"What knowledge or skills do these students seem to show related to using data?"* and *"What are some points of confusion or opportunities for further learning?"*

> Higher-scoring responses for Dimension 1 include more student ideas, a broader range of ideas, and greater conceptual depth. These responses reflect a nuanced understanding of student thinking: they may acknowledge that students' ideas may be more or less "solid," contextual, or difficult to ascertain. Stronger responses may include the desire to know more about students' thinking.

Dimension 2: Planning for instruction

Dimension 2 assesses teachers' ability to describe instructional goals, activities, and strategies that support students' progress toward greater data fluency.

In order to plan for instruction, teachers need to

- be aware of relevant knowledge, skills, and habits of mind for data fluency in mathematics and science at their students' grade level
- align instructional activities with specific data, math, or science learning goals
- develop structures and structures that support students to move beyond procedural work with data, and instead, engage with data as a conceptual, sensemaking endeavor
- understand what makes particular math, science, or data concepts particularly difficult to learn, and
    - be aware of a broad range of instructional strategies for scaffolding student learning with and about data
    - be aware of how technology can help redress some of the problems that students face

Most of the codes relevant to this dimension came from responses to the items that asked, "What are some points of confusion or opportunities for further learning?", "Imagine that you are Amari and Ali's teacher. What could you do to help them strengthen their understanding?," and "How would you modify Ms. Humphrey's goals to meet the needs of your class or classes?"

> Higher-scoring responses for Dimension 2 are more specific, more relevant to Ali and Amari’s difficulties, and more focused on sensemaking and conceptual understanding rather than merely procedural fluency.

Dimension 3: Learner-centered pedagogical orientation

Dimension 3 assesses the degree to which the teacher’s responses convey a learner-centered orientation, in which students are positioned as active agents in their own learning.

Learner-centered environments include the following features:

- students actively engage with activities, language, and tools
- collaborative learning
- student-to-student discourse
- student ideas and perspectives are valued
- the classroom culture supports student learning (norms and routines help students feel safe collaborating and holding data-fluent dispositions)
- students are encouraged to take ownership (e.g., students make choices about what questions to pursue, devise their strategies for analyzing data, and reflect on their own learning)
- teachers respond to student thinking by making adjustments to instruction in accordance with student needs

> Higher-scoring responses for Dimension 3 show consistent evidence of valuing one or more features of student-centered learning environments by 1) identifying these features as a strength of the scenario, and/or 2) planning instruction that includes these features.

While Dimension 3 seems to fit more squarely with a general pedagogy rather than pedagogical content knowledge, we noticed that this orientation was a central feature of responses that we felt were conducive to supporting data learning and data habits of mind. It is also in line with one of the project's value statements, emphasizing the importance of valuing student agency in promoting data fluency, as described below:

> *Our professional learning fosters teacher agency, motivation, and creativity by allowing learners to pursue personally meaningful questions. We do this by*

> *encouraging the use of approaches such as exploratory data analysis and informal inference, using rich multivariate data sets that include a range of different data types. We intend for these learner-driven experiences to foster productive data habits of mind and dispositions such as imagination, curiosity, skepticism, and perseverance. These experiences serve as a model for pedagogical approaches that support student agency and engagement.*
>
> — Data Fluency Project Value Statement #2

Preliminary analysis of teachers' pre-assessment responses has shown that this instrument can elicit various responses along these three dimensions. We anticipate that teachers' responses to the posttest will exhibit a greater ability to analyze student thinking, plan data instruction, and foreground learner-centered pedagogical strategies.

It is worth noting that teachers participating in this study had a high level of experience: most reported having 18 or more years of teaching experience, having prior experience teaching data lessons, and feeling confident analyzing data and using tech tools before attending the professional learning. Accordingly, we might expect these teachers to have higher levels of PCK (at both the pretest and the posttest) than math and science teachers with less experience. To help us understand the types of responses that may reflect lower levels of PCK, we may need to administer this instrument to groups of teachers with less experience.

Next Steps

A post-assessment and a post-reflective interview will be conducted with teachers at the end of the academic year after participating in communities of practice with other educators and teaching a data lesson to their students. These instruments will be designed to triangulate the findings that we are observing. Future work to further expand the offerings of this assessment will include developing additional modules that assess other components, such as technological pedagogical content knowledge that support teachers in knowing when and how to use data-tech tools to support data fluency and their knowledge to identify instructional strategies to engage in data practices such as questioning.

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