

Background

- This study explores how elementary pre-service teachers evaluate and perceive assessment tasks about content knowledge for teaching (CKT) for matter and its interactions.
- Developing knowledge about teaching science is critical for elementary pre-service teachers (PSTs), especially to recognize the content challenges that they face, as they plan for, engage in, and reflect on teaching science (Mikeska, Kurzum, Steinberg, & Xu, 2018).
- CKT includes both subject matter knowledge and pedagogical content knowledge (PCK) and is an important mediator in teachers' abilities to engage in critical teaching practices (Ball, Thames, & Phelps, 2008; Baumert et al., 2010; Schneider & Plasman, 2011).
- Elementary teachers face multiple demands to teach multiple subjects (Brobst, Markworth, Tasker, & Ohana, 2017) and many do not feel adequately prepared to teach science (Banilower et al., 2018). Similarly, PSTs' conceptions of teaching science tend to reflect their life experiences, be resistant to change, shape their classroom practice, and influence the decisions about content, activities and strategies to be used (e.g., Fives & Buehl, 2016; Hewson & Hewson, 1987, 1989; Koballa, Glynn & Upson, 2005).
- Analysis of teaching scenarios has the potential of eliciting, modifying or reinforcing PSTs' conceptions of good science teaching (Yung, Zhu, Wong, Chen & Lo, 2013).

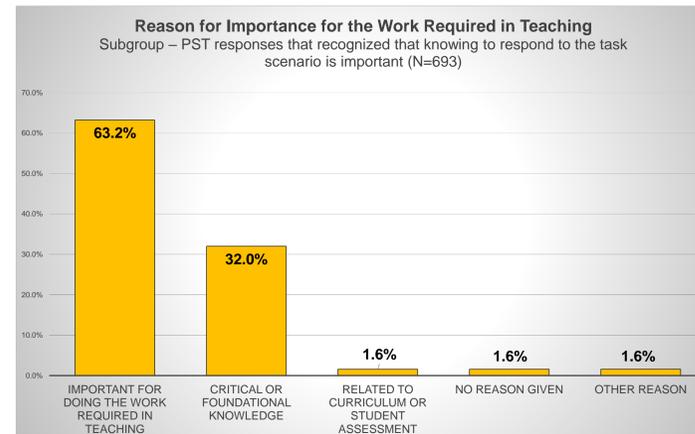
Methods

- We developed 126 items to measure elementary PSTs' content knowledge for teaching (CKT) about matter and its interactions.
- Items were aligned to the NGSS' disciplinary core idea of 'Matter and its Interactions' (PS.1) for K-2 or 3-5 grade bands and the 'Work of Teaching Science' (WoTS) framework that describes science-specific teaching practices (Mikeska, Kurzum, Steinberg, & Xu, 2018).
- Seventy-nine PSTs completed cognitive interviews using concurrent think aloud methodology (Ericsson & Simon, 1984). PSTs were asked if they thought that the items were clear and connected to classroom practice.
- PSTs were from different higher education institutions and geographic settings. Most of the participants self-identified as female (96%) and White (78%), which is similar to the population of elementary teachers in the US (Banilower et al., 2018).
- Interview transcripts were segmented by assessment task and then coded and analyzed using online software. Successive rounds of calibration were conducted in the use of the coding scheme.

Categories and Results

Reason for Importance for the Work Required in Teaching

PSTs recognized that knowing how to respond to the specific CKT item scenario is important for the work of elementary teachers in 94% of the responses (among 738 responses in total). Only in 3% of the responses participants did not consider that knowing how to respond the item scenarios is important (uncertain / no response 3%).

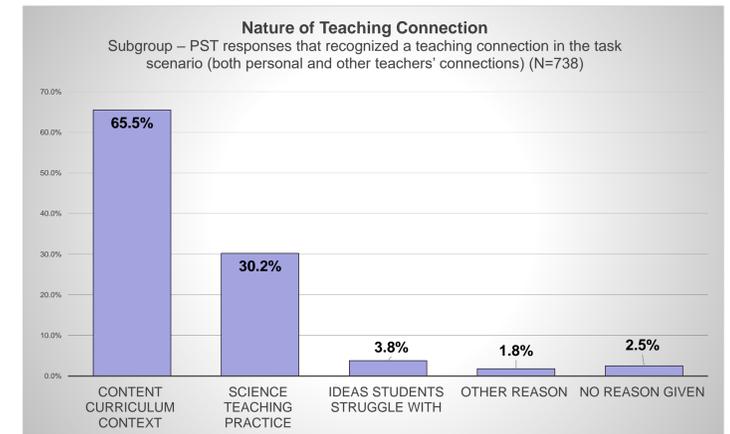


Codes for Reason for Importance for the Work Required in Teaching

Code	Description	Example
Important for doing the work required in teaching	Indicates that the teacher mentioned how teachers must know the content in order to engage in specific science teaching practices.	I think that it's important to also have learning goals that are titled to create lessons but are relevant to your learning goals and that when you have a lesson, you have a learning goal in mind [Pre-service teacher 58; Item A]
Critical or foundational knowledge	Indicates that the teacher mentioned how a scientific concept/fact/idea is critical or foundational knowledge for them to have as a teacher to help students learn, or to the discipline itself.	Just so that they can show their students that no matter what I do to this, I'm still going to have this many blocks, it's just not in this shape anymore. They need to be able to prove to the students that I still have so and so many pieces; it just looks like this now. [Pre-service teacher 60; Item A]
Related to curriculum or student assessment	Indicates that the teacher mentions how this scientific concept/fact/idea is part of the curriculum that is taught at a particular grade level or content that is part of the assessments they use for students.	With the new Next Generation Science Standards, this is probably part of the elementary school curriculum now so I think it's important for teachers to know [Pre-service teacher 79; Item C]

Nature of Teaching Connection

PSTs recognized a connection between the CKT item and their own teaching experience in 54% of the responses and visualized a possible connection to other elementary teachers' work in 42% of the responses (among 769 responses in total). In 2% of the responses, pre-service teachers did not recognize any connection between teachers' work and the CKT tasks (2%) or expressed uncertainty (2%).



Codes for Nature of Teaching Connection

Code	Description	Example
Content/curriculum/context	Indicates that the teacher mentioned the classroom content, curriculum, or context in a way that does not highlight the specific science teaching practice evident in the teaching scenario provided in the item.	Yeah, it does sort of remind me of, in my second-grade internship placement. One day my teacher was teaching balancing equations by using the natural balance. And she put cubes in like, on different sizes of balance to show like how to balance the equation and it reminds me... [that] doesn't mean that [there are differences in] how much matter they have in them. [Pre-service teacher 60; Item A]
Science teaching practice (STP)	Indicates that the teacher mentioned the specific science teaching practice evident in the teaching scenario provided in the item, focusing on the teacher's role.	"It's very important for teachers to be able to look at a claim that a student makes and to be able to know evidence to be able to verify whether that claim is correct or incorrect, or to be able to challenge student claims, even if the student makes the claim that is correct" [Pre-service teacher 17; Item B]
Ideas students struggle with	Indicates that the teacher explicitly referenced specific ideas or concepts that people or students often find difficult.	"My students did have troubles in asking the difference between solid and liquid based off of their shape. It's for a matter unit when you're supposed to introduce solids generally keep their shape and liquids don't. I have students feel like, oh, but you can fold off your clothes into like a smaller space, so as to keep its shape. So, it's a very challenging subject to teach. [Pre-service teacher 14; Item B]

Research and Interview Questions

RQ1. To what extent and for what reasons are these CKT items identified as assessing important knowledge for elementary science teachers?

RQ2. To what extent and in what ways do these CKT items connect to the work of teaching elementary science?

Interview question: *Do you think it's important for elementary teachers to know how to answer this question?*

Interview Question. *Did this scenario remind you of something you've experienced in your own teaching? [If not] Do you think this is a scenario that other teachers might encounter?*

CKT Item Examples Focused on Matter and Its Interactions

Item A: Snap Blocks

During a unit on matter, Ms. Johnson asks her second-grade students to take apart a cube made of snap blocks pieces (see image 1) and examine the number and color of the pieces.



Image 1

Students are then asked to use all the pieces to make something new. After all students create their own object, they look at one another's objects (see image 2). Ms. Johnson guides students to recognize that the number and color of the pieces in the new object remain the same as they try to identify what the object is. Finally, the class has a whole-group discussion that focuses on the potential of a new object being created from the original cube and the wide variety of objects created from the same starting cube.

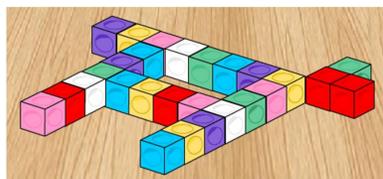


Image 2

Which of the following concepts about matter does this lesson best support at a second-grade level of understanding?

- Matter can undergo changes that are reversible.
- Matter can be described by observable properties.
- Materials have properties that make them suitable for different purposes.
- Matter is made of small particles that can be arranged in different ways.

Item B: Liquid Definition

In Ms. Quintana's second-grade class, students explore the properties of different solids and liquids. Based on the exploration findings, students create definitions for solids and liquids.

While completing the definition for liquids, one student makes the claim that "all substances that look like they take the shape of their containers are liquids." Ms. Quintana is planning to include a follow-up activity for students to collect more data and refine their ideas.

Which TWO of the following materials will best challenge this claim and help the student improve his definition?

- Maple syrup
- Ice block
- Salt
- Milk
- Rice

Discussion and Implications of this Study

- Our findings suggest that pre-service teachers tend to recognize the centrality and importance of these assessment tasks for the work typically done in elementary classrooms, even if they do not report having firsthand experience with the scenario.
- The results of this study become a first step in validating assessment tasks related to CKT for matter and its interactions. While participants tended to provide a general rationale about why these tasks were important for the work of teaching, fewer participants described explicit connections between a task scenario and a specific science teaching practice related to teachers' work.
- Developing assessment tasks that are pertinent to the work of elementary pre-service teachers and their experiences is essential. Through this process, they can broaden their awareness of different teaching scenarios, recognize connections between the work of elementary teachers and their prior experiences, and increase their repertoire of instructional strategies, content representations, and activities (Yung, Zhu, Wong, Chen & Lo, 2013).

Scan for more information

