Creating a Summative Assessment to Measure Elementary Pre-Service Teachers’ Content Knowledge for Teaching (CKT) about Matter and Its Interactions

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Background

- Research emphasizes that content knowledge alone is insufficient for effective teaching. (Ball, Thames, & Phelps, 2008; National Research Council, 2012; National Board for Professional Teaching Standards, 2008)
- CKT includes both subject matter knowledge and pedagogical content knowledge (PCK), and may especially benefit elementary science teachers, who tend to struggle with understanding science content and science-specific pedagogies to effectively support student learning. (Duschl, Penuel, &eyed, 2007; Bress, Garcia, Guerra, Laspisa, Peters, Scharff, & Vakola, 2008)
- CKT supports teachers’ abilities to engage successfully in critical teaching practices. (Baumert et al., 2010; Hill, Dean, & Goffney, 2007; Hill, Vavrus, & Shavelson, 2008; Mikeska, Kurzum, Steinberg, & Xu, 2018)
- Most CKT assessments require substantial time to administer and score, making it challenging to implement on a large scale to measure science teachers’ CKT across multiple sites or longitudinally.
- Assessing CKT for foundational science topics, such as matter and its interactions, is critical to support preservice elementary teachers.

CKT Item Development Process

1. Use NGSS to unpack each topic area
2. Define resources to create instructional audience
3. Draft initial CKT items
4. Review and revise draft items in working groups
5. Complete cognitive interviews and receive external feedback
6. Review and revise items using data from working groups
7. Conduct pilot test and analyze results
8. Conduct field test and analyze results
9. Select and revise items for field test
10. Conduct field test and analyze results
11. Review items for use by teacher educators

Evidence for Item Revision

- Students may struggle to understand that the liquid must have gone somewhere.
- Students may not think a word (or two) is plausible.

Feedback from Cognitive Interviews

- Students may not understand that the liquid must have gone somewhere.
- Students may not think a word (or two) is plausible.

Next Steps and Resources

- Use field test data to further refine assessment items.
- Use CKT assessment to determine specific areas of CKT that preservice teachers need to work in to develop in university courses.
- Develop CKT instructional materials to support preservice teachers.

Tools and Resources to Support Item Development

- Resources for Creating Item Scenarios: Content Main Ideas
  - Melting and freezing are generally explained as being a result of heating (warming) and cooling the liquid, with explanations stating that “ice changed into water” or “water changed into ice.”
  - Explanations for evaporation and condensation are challenging for K-2 students.
  - Struggle to realize that the liquid must have gone somewhere (evaporation)
  - Students may not think a word (or two) is plausible.
- Item Identification and Alignment
  - Item type: Multiple choice single selection
  - NGSS PE 2-PS1-4 Construct an argument with evidence that some changes are caused by heating or cooling can be reversed or cannot.

Work of Teaching Science

The “Work of Teaching Science” (WOTS) framework details the science-specific teaching practices most critical for beginning elementary science teachers. (Mikeska, Kurzum, Steinberg, & Xu, 2018)

WOTS Instructional Tools Categories

1. Scientific Instructional Goals, Big Ideas, and Topics
2. Scientific Investigations and Demonstrations
3. Scientific Resources (texts, curriculum materials, etc.)
4. Student Ideas
5. Scientific Language, Discourse, and Vocabulary
6. Scientific Explanations
7. Scientific Models and Representations

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Mapping of CKT Matter Items

Our team developed a variety of assessment items to measure pre-service elementary teachers’ CKT for teaching matter and its interactions.

- Item assignments were organized so that each WOTS category was represented in each content category for all grade bands.
- Item writers were instructed to vary different aspects of their items (e.g., item type, teachers’ gender and ethnicity, use of graphics, etc.) to generate a broad array of CKT matter items.
- Individual item data was tracked to manage each item’s status and specifications.