EDUCATIVE CURRICULUM MATERIALS FOR TEACHER EDUCATORS

Building Elementary Teachers' Content Knowledge for Teaching About Matter

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Professional Learning Community (PLC) for Teacher Educators

Teacher educators enter the profession from a variety of entry points and from different disciplinary backgrounds (Berry & van Driel, 2013). This, combined with the likelihood that preparing future teachers was not an explicit component of their graduate education (Abell et al., 2009), means that teacher educators vary greatly in their preparedness for this role.

Curriculum materials have been long suggested as a means of supporting K12 teacher learning (Bruner 1960; Ball & Cohen, 1996). These materials, which provide opportunities for teachers to develop new skills and practice as they enact them with students, have come to be known as educative curriculum materials (ECM; Davis & Krajcik, 2005). Yet, despite Cochran-Smith (2003) suggesting the field attend to the development of curricula for teacher education, we know of no ECM intended specifically for supporting the learning of science teacher educators.

Given much of the learning of teacher educators takes place 'on the job' (Dinkelman et al., 2006), we believe curriculum materials have the potential to play an important role in supporting teacher educators' ongoing professional learning. To this end, we have worked to create a network among teacher educators who are using the materials we developed in their courses.

Year-Long PLC Cohort

We facilitated a year-long professional learning community from 2021-2022 for 16 teacher educators from universities across the US. The group met biweekly via Zoom to develop an understanding of CKT and familiarize themselves with the CKT Packets in Fall, then supported each other during implementation in Spring by discussing problems of practice.

Research on Curriculum Implementation

We conducted a concurrent mixed-methods study of teacher educators' implementation of the CKT Packets to understand:

Under what conditions do teacher educators' (TEs') uses of CKT curriculum materials support preservice teachers' (PSTs') development of CKT about matter and its interactions?

Methods

Teacher educators served as their own comparison group in a cohort control quasi-experimental study.

Cohort Control Term (n = 141 PSTs): 'Business as usual' teaching course

Intervention Term (n = 139 PSTs): Same course implementing 2-6 CKT Packets

Year-long PLC

- Learned about CKT and explored the six CKT Packets
- Supported each other (N = 8 teacher educators) by sharing planning & implementation experiences

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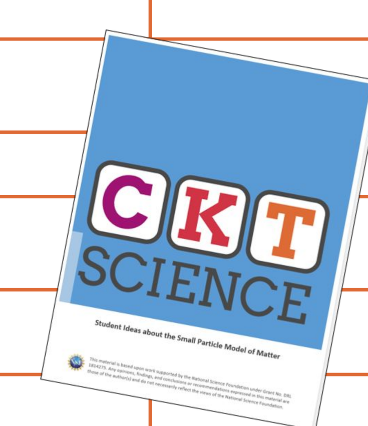
In our project, we operationally define content knowledge for teaching (CKT) as the intersection of specific science content ideas and the Work of Teaching Science (WOTS; Mikeska et al., 2018), a framework that identifies science-specific teaching practices that are most critical for beginning elementary teachers. In our work, we chose to focus on CKT in relation to matter. As emphasized in the Next Generation Science Standards (NGSS Lead States, 2013) and Framework for Science Education (NRC, 2012), the concept of matter is central to understanding many scientific ideas. While there is a robust empirical base highlighting student difficulties and possible learning progressions for matter (cf. Tsarpalis & Sevian, 2013) there is currently a lack of content-specific teaching knowledge relevant to teaching about matter in the elementary years (Smith & Plumley, 2016). We used an empirically and theoretically grounded process described by Davis and colleagues (2014) to develop a set of design heuristics for educative curriculum materials (ECM) to support *teacher educator* as well as preservice teacher learning. Using these heuristics, we developed a set of six instructional modules we refer to as "CKT Packets". Rather than being an entire curriculum, these are intended to be used by teacher educators to supplement their instruction in content and/or methods courses for future elementary teachers.

	Materials	Properties of Matter	Small Particle Model	Changes in Matter	Conservation of Matter
Instructional goals & big ideas					
Investigations & demonstrations					
Scientific resources for teaching					
Students' ideas					
Scientific language & discourse					
Scientific explanations					
Scientific models & representations					

CKT for Matter includes: Eliciting and interpreting students' ideas about the small particle model of matter



Design Heuristic 1

ECM should help teacher educators adapt and use resources with their preservice teachers in pedagogically appropriate ways.ECM should help make the work of teaching science visible to preservice teachers, and provide rationales for why this work is important. ECM should make explicit how specific science teaching practices correspond to different concepts and provide recommendations for how those might be introduced to preservice teachers in different contexts and courses.

Design Heuristic 2

ECM should help teacher educators understand how preservice teachers develop CKT for science. ECM should support anticipating, eliciting, and interpreting preservice teachers' ideas, and provide insight into how they might address those ideas, for example by giving suggestions of assessment probes, discussion questions, and activities likely to confront preservice teachers' initial thinking about teaching science in productive ways.

Design Heuristic 3

ECM should help teacher educators support preservice teachers in confronting gaps in their knowledge, making connections across concepts, and understanding why strong content knowledge is important for teaching.ECM should provide tools for helping preservice teachers develop a deep conceptual understanding of science content as a foundation for building CKT. ECM should emphasize key differences between the content understanding required of preservice teachers and elementary students.

Educative Features	Description and Alignment to Design Heuristics
CKT Summary	Expository text outlines key ideas related to the content focus and WOTS practice emphasized in the module. (Heuristic #3)
NGSS Alignment	Background information identifies connections to Performance Expectations, DCIs, SEPs, and CCCs as well as assessment boundaries and connections across elementary grades. Includes relevant information about progressions of learning, such as focusing on 'particles' versus atoms in the elementary grades. (Heuristic #3)
CKT Task and Answer Key	Provides a scenario-based task to elicit preservice teachers' CKT, including elaboration on expected incorrect/correct responses from preservice teachers and possible reasoning for their answers. (Heuristics #1 & 2)
Implementation Plans	Suggests activities for teacher educators to engage preservice teachers with the CKT tasks. Plans include embedded teaching tips, rationales for the learning activities, potential connections to other course concepts or goals, suggestions for modifications, and possible preservice teacher responses. Both single session and multi-session implementation plans are offered. (Heuristics #1 & 2)
CKT Reading Pages	Reproducible practitioner-friendly articles provide information about the science ideas elementary students are intended to develop, why these are important, and specific teaching practices that support that. Discussion questions are included for teacher educators. (Heuristic #3)
Related Resources	Provides research literature, practitioner articles, web-based resources, etc. to support teacher educators in understanding CKT and identifying additional resources to support preservice teacher learning. (Heuristic #2)
Options for Going Further	Provides alternative suggestions for engaging preservice teachers more deeply in applying their CKT in activities that approximate teaching practice. (Heuristics #1 & 2)

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Analysis

Quantitative

- Examined salient sources of variance in preservice teachers' (PSTs') CKT assessment outcomes by accounting for PST (level one) and teacher educator (level two) factors in a multilevel model.

$$CKTpost_{ij} = \gamma_{00} + \gamma_{01}PacketsImplemented + \gamma_{02}CKT_{pre} + \gamma_{03}MedianItemTime_{pre} + \gamma_{04}MedianItemTime_{post} + \gamma_{05}CoursePrep + \mu_{0j} + \varepsilon_{ij}$$

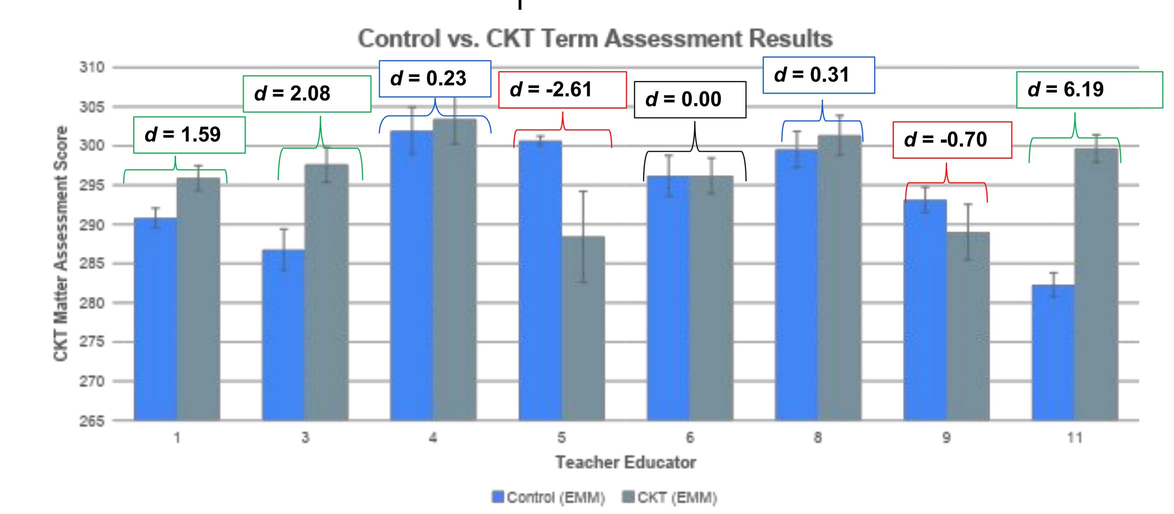
Qualitative

- Examined interview transcripts, teaching logs, observation notes, and information about implementation.
- Identified excerpts that illuminate barriers and supports for teacher educators' uses of the CKT educative curriculum materials.
- Coded excerpts using thematic analysis to examine variations across teacher educators related to their context and implementation.

Results

Multilevel Model Results

- PSTs' CKT pretest scores and median item time (pre & post) significantly predicted CKT posttest scores.
- The prior coursework around K-5 teaching of matter content was not a significant predictor of PSTs' CKT posttest scores.
- Accounting for PST-level predictors, the number of CKT Packets teacher educators implemented was significant.
- Altogether, these variables accounted for 71.3% of the variance in PSTs' CKT posttest scores.



Qualitative Themes: Influences on Implementation

- Disruptions to course context vs. typical experience
- Teacher educator motivation for implementing curricula
- Identification of productive 'entry points' that align with existing course goals and emphases
- Experience with the instructional routines of the CKT Packets
- Approach to first-time use and uptake of educative features

Summary and Limitations

Summary

- Packets and support for their use (i.e., PLCs) can impact teacher educators' practice and the degree to which PSTs develop CKT, however, 'productive' use of CKT packets may be influenced by a variety of personal and contextual factors.

Important Limitations

- Small sample of teacher educators and PSTs
- Variation in implementation (i.e., 2-6 packets implemented)
- Teacher educators' *first* implementation of materials
- PSTs' participation was not incentivized which limited their motivation to complete assessment data collection