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Mapping the Complexities of Teacher Change: A Conjecture Mapping Approach to Designing Computational Thinking Professional Development

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Abstract: This empirical case study utilizes conjecture mapping to capture and systematically map conjectures about the support needed for K-12 teachers to incorporate computational thinking into teaching. The case analysis highlighted a teacher's year-long professional development experience focused on integrating computational thinking. The evolving conjecture map provides a framework to trace and understand relationships between the learning designs, activities, and teacher outcomes. Using rich data from the teacher's experience, the study tests and refines the hypothesized connections laid out in the original conjecture map to build an understanding of effective computational thinking professional development design.

Introduction

With the increasing emphasis on computational thinking (CT), researchers are investing in professional development (PD) to build teachers' capacities for integrating CT into classrooms (Kafai & Proctor, 2022). However, we have a limited understanding of effective approaches to scaffolding this complex pedagogical shift. The transition from theory to effective practice is filled with complexities. Design-based research highlights the need to iteratively design and empirically test interventions in authentic contexts (Hoadley & Campos, 2022). One important method in this process is conjecture mapping, which facilitates systematically documenting and refining hypotheses about how a learning innovation will work in real-world settings (Sandoval, 2014). Therefore, this study asks: What conjectured relationships in a PD design targeting computational thinking integration are supported through empirical tracing of one teacher's experience?

Researchers have shown that instructional coaching is promising way to provide ongoing support and build a sustainable professional learning community (Saclarides & Lubiensky, 2021). To this end, we have designed PD experiences leveraging the past research experience in teachers' professional learning. In this study, we considered these theoretical underpinnings that help us understand one participant's experience in one-on-one coaching and how that may have shaped her subsequent outcomes.

Method

This study reports a partial effort in a bigger research project aimed at supporting elementary school teachers' professional learning in CT and their integration of CT into their classrooms. The PD experience consists primarily of a series of online asynchronous modules about the CT, monthly PD workshops on CT, monthly coaching sessions, and the co-designing and implementation of the CT classes. We followed a case study approach that focused on one teacher, Cassie (pseudonym), for 10 months. We utilized a longitudinal approach that involved continuous observation to understand her growth and development. The conjecture map (Figure 1a) illustrates the hypothesized relationships about what and how particular aspects of the PD design support teachers in integrating CT in their teaching practices. The empirical evidence will be used to understand and refine the conjecture map, confirming, challenging, or elaborating the conjectured relationships to facilitate future iterations of the PD design. We used conjecture mapping merits further investigation as an empirical research tool to connect the theoretical understandings and the empirical evidence to construct theories (Hoadley & Campos, 2022).

Findings

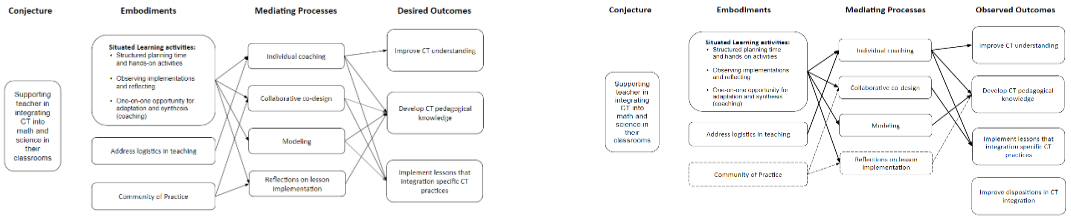
The case study presents evidence supporting several relationships between the mediating processes and the desired teacher outcomes delineated in the conjecture map. First, the individual coaching support helped Cassie improve her understanding of challenging CT concepts, such as decomposition and abstraction, which were challenging to her. Second, the individual coaching sessions helped Cassie build pedagogical knowledge about CT integration. As indicated by the coaching data, eight out of the ten observed coaching sessions focused on discussing ideas and providing pedagogical suggestions for CT integration. Third, the individual coaching facilitated Cassie's

implementation of CT integration in her class. As indicated in the coaching data, through the mid to the late phase of PD, the content of coaching sessions primarily concentrated on exploring and discussing pedagogical strategies for the integration of CT and design thinking. Fourth, the collaborative co-design process facilitated Cassie's implementation of CT-integration lessons in her class.

Based on the evidence that emerged from this case data, we refined the original conjecture map and created a new conjecture map (Figure 1b) to depict the relationship between implemented designs, validated mediating processes, and observed outcomes. The solid arrows represent relationships that are supported by the data of the case. The dotted boxes represent embodiment elements and mediating processes that were not observed in this particular case.

Figure 1

The Initial and Data-Informed Conjecture Map



a. Initial Conjecture Map b. Data Informed Conjecture Map

Although our PD design initially focused on fostering a teacher community of practice, expecting the collaborative lesson design and reflective practices to generate teacher outcomes, these interactions and activities were not evident in Cassie's case. Instead, Cassie highlighted the value of her interactions with her coach, underscoring its impact on enhancing her understanding of CT and advancing her teaching expertise. This finding suggests that although a community of practice was integrated into the PD design, it appears that this design did not effectively generate mediating processes that would lead to desired learning outcomes. Similarly, although we anticipated that collaborative co-design would enhance teachers' pedagogical knowledge in CT integration and that modeling CT integration would aid in the teacher's implementation of CT integration, and while such outcomes were observed, there was a lack of strong evidence in the data to confirm these linkages. Additionally, beyond what is delineated in the proposed conjecture map, we observed improved dispositions in integrating CT.

Discussion and scholarly significance

This study utilized conjecture mapping to highlight key mediating processes that were effective in the professional learning experience. The findings add to the design-based research approaches for teacher PD for CT. It demonstrates the value of conjecture mapping as an empirical tool to develop and refine theory around effective professional learning. The refined conjecture map provides an enhanced understanding of how elements of PD design generate mediating processes that lead to learning outcomes. These insights can inform iterative improvements to future PDs that target CT classroom integration. Future research should focus on accumulating diverse cases and richer data sources to further validate and elaborate the relationships in the conjecture map.

References

Kafai, Y. B., & Proctor, C. (2022). A revaluation of computational thinking in K–12 education: Moving toward computational literacies. *Educational Researcher, 51*(2), 146–151.

Hoadley, C., & Campos, F. C. (2022). Design-based research: What it is and why it matters to studying online learning. *Educational Psychologist, 57*(3), 207-220.

Sandoval, W. (2014). Conjecture mapping: An approach to systematic educational design research. *Journal of the Learning Sciences, 23*(1), 18-36.

Saclarides, E. S., & Lubienski, S. T. (2021). Teachers' mathematics learning opportunities during one-on-one coaching conversations. *Journal for Research in Mathematics Education*, *52*(3), 257-300.

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