Breaking Silos: Integrating Computational Thinking Across Elementary Subjects for Future Educators

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Abstract

This study examined the role of preservice teachers' (PSTs') teaching self-efficacy in a training program, which focused on integrating computational thinking (CT) in elementary subjects. Results showed that PSTs' CT knowledge significantly predicted their teaching self-efficacy though the explanatory power was weak. Evidence from the qualitative analysis on PSTs' post-lesson reflections showed different patterns between PSTs with positive and non-positive teaching self-efficacy. These results not only provided insights into future research but also highlighted the need to develop PSTs' pedagogical skills alongside their CT knowledge during the training.

Keywords

computational thinking; teacher education

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1 Introduction

Integrating computational thinking (CT) education in K-12 subject courses (integrated CT education, in short) has been a growing trend to develop students', especially elementary students', CT competence [1]. However, teacher preparation and development on integrated CT education are still in their infancy [3]. Existing studies on preservice teacher (PST) training focused on developing participants' CT knowledge [1, 2], indicating a lack of systemic development on PSTs' competence of integrating CT in elementary subject courses using appropriate technology and pedagogy. Teaching self-efficacy (TSE) has often been used to measure the training outcome, yet relevant activities in the training were limited to lesson review and development rather than actual classroom teaching [5, 7].

In this study, we implemented a training program for PSTs majoring in elementary education at a four-year university in the southern U.S. The three-semester program aimed to develop PSTs' competence of integrating CT in elementary subject courses using appropriate technology and pedagogy. In the first semester, a five-day seminar was dedicated to integrating CT into English Language Arts and social studies subjects. A four-day seminar in the second semester focused on integrating CT into mathematics and science subjects. In both semesters, CT workshops were offered at the beginning to develop PSTs' CT competence through unplugged, coding, and robot activities. Thereafter, PSTs took sample lessons and participated in pedagogy discussions. In the third and last semester, PSTs developed and taught integrated CT lessons in elementary classrooms as a part of their teaching practicum.

The purpose of this study is to examine the roles of PST's TSE in their professional learning experiences that focused on integrated CT education. Our research questions are: *1) How did PSTs' CT knowledge predict their TSE at the end of training seminars? 2) In what ways did PSTs' post-lesson reflections vary by their TSE levels?*

2 Methods

At the end of the second semester, PSTs completed a CT knowledge test, which included six multiple questions assessing their application of CT in block-based coding tasks [8]. Meanwhile, PSTs took a TSE survey containing thirteen Likert-scale items rated from 1 (Strongly Disagree) to 5 (Strongly Agree) [6]. After teaching integrated CT lessons, the PSTs submitted individual reflections focusing on the benefits and challenges of their lessons.

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To address Question 1, a linear regression was conducted with PSTs' total scores of the CT knowledge test being the predictor and the averages of their TSE as the outcome variable. To address Question 2, the PSTs were divided into two groups according to their TSE: those with positive TSE (average ≥ 4) and those with non-positive TSE (average < 4). A qualitative thematic analysis [4] was conducted on PSTs' post-lesson reflections and the results were compared between the two groups.

3 Results

Results of the regression showed that PSTs' **CT knowledge** significantly predicted their TSE, $F(1, 129) = 5.64$, $p = 0.02$ (Table 1). However, only 4.2% variance in PSTs' TSE was explained by their CT knowledge.

Table 1: Regression Results with 95% Confidence Interval

Predictor	Estimate	SE	CI	
			LL	UL
Intercept	2.97	0.25	2.46	3.47
CT Knowledge	0.12	0.05	0.02	0.21

105 PSTs submitted the **post-lesson reflections**. The positive impact of the integrated lessons on students' engagement was a predominant theme ($N = 102$), for example, *"My students were all excited to use the robot and they enjoyed coding the robot to find the shape that was given to them. Using the robot made the students have fun while learning about math."* More PSTs with positive TSE reported the benefits of integrated CT lessons on students' problem solving, critical thinking, and collaboration skills than those with non-positive TSE, even though the latter group was larger, for example, *"This interdisciplinary approach fosters critical thinking, problem-solving skills, and creativity, preparing students for success in an increasingly digital world."* Three PSTs with non-positive TSE did not think the lessons benefit students based on their observations of students' classroom behavior or their perspectives on the necessity of teaching CT in elementary classes, for example, *"I do not think it benefitted them. I think the excitement of the robots made it too overwhelming for them to further their knowledge in the content."*. The top challenges reported by PSTs differed between those with positive and those with non-positive TSE. The former group most frequently cited the limit of time and classroom space (*"The challenge that arose was that I felt like I was not given an adequate amount of time to really dive into this lesson with the students due to the fact that I was only given a small block of time to teach during the day."*), followed by the technology issues (*"The challenge I faced when doing this lesson was setting up the Mbot Neo. I struggled setting it up to do the correct code. It took a minute to figure out the issue."*). For PSTs with non-positive TSE, the most common challenges included lesson planning, especially the difficulty of designing lessons that meaningfully integrated two subject topics, for example, *"I struggled to make the connections between using the robots and the ELA lesson in which I was planning to teach. I did not understand how the students were going to be able to code the robots with the limited time allotted for the lesson. However, I received advice from XXXX (names removed for anonymity) that eased my mind about the lesson and guided me in the right direction."*. They also reported the challenges of managing classroom behavior when students were too excited and preoccupied with playing with robots, for example, *"I found it challenging when teaching the lesson to keep students from asking unrelated questions and just wanting to play with the MTiny bot."*.

4 Discussion and Future Work

Results of our study provide insights into what we need to prepare our PSTs on integrated CT education. Their CT knowledge is essential; however, it is not the sole determinator to boost their TSE. According to the qualitative evidence from PSTs' post-lesson reflection, we posit that other factors, such as their pedagogical knowledge, especially classroom management strategies, are also important in building their TSE. Future studies may include these factors and examine their impact on PSTs' TSE. In addition, our study shows the importance of teaching practicum as a part of the training. Without real classroom experiences, PSTs would not observe young students' excitement and engagement with the learning activities. Likewise, they may not engage in serious planning for strategies to handle upcoming classroom challenges. We also identified different patterns of post-lesson reflections between PSTS with positive and non-positive TSE. Future studies may explore reasons behind the differences to improve the design of PST training.

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References

[1] Rachel F. Adler, Joseph Hibdon, Hanna Kim, Scott Mayle, Brittany Pines, and Sudha Srinivas. 2022. Assessing computational thinking across a STEM curriculum for pre-service teachers. *Education and Information Technologies* 28, 7 (2022), 8051–8073. doi:10.1007/s10639-022-11508-4

[2] Marina U. Bers and Merredith Portsmore. 2005. Teaching partnerships: Early childhood and engineering students teaching math and science through robotics. *Journal of Science Education and Technology* 14, 1 (2005), 59–73. doi:10.1007/s10956-005-2734-1

[3] Hasnaa Chaabi, Abdellah Azmani, and Juan Manuel Dodero. 2025. Bridging computational thinking research and practice of pre-service and in-service teachers. *Humanities and Social Sciences Communications* 12, 1 (2025). doi:10.1057/s41599-025-04895-9

[4] J. Fereday and E. Muir-Cochrane. 2006. Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International journal of qualitative methods* 5, 1 (2006), 80–92.

[5] Andrea Ramirez-Salgado, Christine Wusylko, Lauren R. Weisberg, Johnny Delgado, and Maya Israel. 2025. Preparing elementary preservice teachers to integrate computational thinking in the curriculum. *ACM Transactions on Computing Education* (2025). doi:10.1145/3744751

[6] Peter J. Rich, Ross A. Larsen, and Stacie L. Mason. 2020. Measuring teacher beliefs about coding and computational thinking. *Journal of Research on Technology in Education* 53, 3 (2020), 296–316. doi:10.1080/15391523.2020.1771232

[7] Esra Tankiz and Nilüfer Atman Uslu. 2022. Preparing pre-service teachers for computational thinking skills and its teaching: A convergent mixed-method study. *Technology, Knowledge and Learning* 28, 4 (2022), 1515–1537. doi:10.1007/s10758-022-09593-y

[8] Jessica Vandenberg, Arif Rachmatullah, Collin Lynch, Kristy E. Boyer, and Eric Wiebe. 2021. Interaction effects of race and gender in elementary CS attitudes: A validation and cross-sectional study. *International Journal of Child-Computer Interaction* 29 (2021). doi:10.1016/j.ijcci.2021.100293