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Preservice Teacher Learning During a Structured Computational Thinking Field Experience

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This paper explores the experiences and learning outcomes of preservice elementary teachers (PSTs) as they integrate computational thinking (CT) into their teaching practices during a structured field experience. Through a qualitative content analysis of video reflections from 27 PSTs, the study examines how teaching CT lessons to K–2 students enhances the PSTs' understanding of CT and their pedagogical skills. The field experience, which involved hands-on activities using ScratchJr and Tale-Bot, revealed several key themes: the importance of hands-on learning for student engagement, the benefits of empowering students to take an active role in their learning, the necessity of balancing teacher guidance with student independence, and the development of PSTs' self-efficacy in implementing CT activities. The findings suggest that structured field experiences play a crucial role in preparing PSTs to effectively integrate CT into elementary education, bridging the gap between theoretical knowledge and practical application. The study emphasizes the need for teacher preparation programs to incorporate real-world teaching opportunities to foster PSTs' self-efficacy and adaptability in teaching CT, thus equipping them to meet the demands of 21st-century classrooms.

INTRODUCTION

As computer science (CS) and computational thinking (CT) have had an increasing presence within the K–12 classroom, elementary teachers have been asked to find ways to integrate CS and CT into their classroom instruction despite having very full daily schedules already (e.g., Israel et al., 2015; Rich et al., 2019). One common suggestion for adding CS/CT into elementary classrooms is for teachers to integrate CS/CT concepts into existing core content, such as English language arts, mathematics, or science (e.g., Cabrera, 2019; Century et al., 2020; Rich et al., 2019). This integrated approach helps not only to manage time constraints but also enhances learning in CS/CT and content areas (Israel et al., 2015). Although there is a growing body of work examining elementary teachers and connections between CT and their existing content and practices (e.g., Rich et al., 2019; Yadav et al., 2019), we still have limited information on how to effectively integrate CS into elementary classrooms and how to support inservice teachers in this endeavor. This problem is further complicated when thinking about how we best prepare future teachers to teach in an area, like CS/CT, where they have limited background, experiences, and skills and few teacher preparation programs offer dedicated courses in CT/CS (Moore et al., 2020; Yadav et al., 2014). Ertmer and Ottenbreit-Leftwich (2010) suggested that when looking at the integration of new topics, such as CT/CS, teacher preparation programs should focus on providing preservice teachers (PSTs) with relevant knowledge, observations of effective instruction, hands-on practice, and opportunities for reflection. Based on a synthesis of research around preparing elementary teachers for computer science instruction, Rich et al. (2021) found that training and preparation that included active participation and practice teaching with children could improve teachers' self-efficacy and attitudes towards teaching CS. Therefore, to better prepare elementary PSTs to integrate CT into their elementary instruction, we need to develop and examine ways in which we can provide preservice teachers not only with relevant knowledge and observations of effective practice but also opportunities to practice and reflect on teaching CS/CT to elementary students.

The ReThinking Circle Time (ReCT) project examined the teaching practices of preservice elementary teachers as they learn to integrate CT into their elementary classrooms. Through a structured field experience embedded into an educational technology course, each preservice teacher was responsible for teaching one of two CT lessons to a small group of elementary students. We wanted to look at PST's views on learning following participation in a CT field experience with elementary students. The research question that guided this work was: *What did preservice teachers learn as a result of a structured field experience about teaching CT to early elementary students?*

LITERATURE REVIEW

In recent years, CT has shifted from being a specialized skill for computer scientists to a fundamental skill essential for all learners (e.g., Buitrago Flórez et al., 2017; Jacob & Warschauer, 2018). There is a growing emphasis on developing CT skills early as they are key thinking and problem-solving abilities needed to understand how computing impacts our world (Caeli & Yadav, 2020). CT has been defined as "a problem-solving process that includes formulating problems, logically organizing data, representing data through abstraction, automating solutions, reflecting on the efficiencies of possible solutions, and generalizing and transferring this process to a variety of problems" (International Society for Technology in Education [ISTE] & Computer Science Teachers Association [CSTA], 2011). Drawing on this definition, we view CT as a foundational skill that preservice teachers can apply to enhance future student learning across disciplines. By equipping students with cognitive abilities to think logically, analyze data and information, identify patterns, decompose problems, and create solutions, CT can significantly contribute to student learning.

Elementary Preservice Teacher Preparation in CS/CT: Challenges and Solutions

Despite widespread recognition of the importance of teaching CS/CT to K–12 students, concerns have arisen about teachers' backgrounds and preparation in these areas (Ottenbreit-Leftwich et al., 2021). A significant barrier to integrating CS into K–12 education is the shortage of certified CS teachers. States offer varying qualification pathways—initial licensure, add-on licensure, and authorization—with differing complexities that may lead to inconsistent levels of teacher qualifications (Ottenbreit-Leftwich et al., 2021). This underscores the need for a coherent system to support teacher preparation in the CS field. Introducing CS/CT concepts into preservice teachers' courses in higher education has been shown to positively influence their understanding of CT concepts and attitudes toward computing, suggesting a potential solution (e.g., Dong et al., 2024; Yadav et al., 2014).

For over a decade, preparing preservice teachers to teach CS has been a persistent issue (Wilson et al., 2010). Integrating CS education into schools of education faces significant challenges, including a substantial gap in the inclusion of CS content within teacher education programs (Yadav et al., 2021). This gap may stem from a lack of adequately trained faculty to deliver the curriculum and difficulties in fitting CS content into the overall program structure. Additionally, there is a recognized need for preservice teachers to engage directly with K–12 classrooms as part of their training. Such exposure not only enhances practical teaching skills but also bridges the gap between theoretical knowledge and real-world application (Yadav et al., 2021).

CT Interventions in Preservice

As teacher educators seek effective ways to better prepare PSTs for teaching CT in their future classrooms, integrating CT into existing coursework—such as educational technology or content methods courses—has been suggested (Mouza et al., 2017; Zha et al., 2020). Six effective methods that improve PSTs' CT skills include: CT courses, programming applications, educational robotics, CT modules embedded in education courses, CT projects involving long-term practical applications of CT concepts, and CT seminars or workshops offering brief, intensive training on CT and programming skills (Dong et al., 2024). These interventions provide PSTs with structured opportunities to learn CT concepts through practical applications like Scratch and robotics tools such as Lego WeDo and Arduino. Notably, specific CT courses are the most common and have the greatest impact on promoting CT skills (Dong et al., 2024).

Research indicates that these types of CT interventions not only enhance PSTs' CT skills but also positively influence their attitudes toward teaching CS/CT (Lamprou & Repenning, 2018; Mason & Rich, 2019; Tankiz & Atman Uslu, 2023; Umutlu, 2022; Yadav et al., 2014). Well-structured coursework integrating CT through practical applications—such as block-based programming (Umutlu, 2022), game design (Lamprou & Repenning, 2018), or lesson planning with a Scratch project (Tankiz & Atman Uslu, 2023)—has shown significant improvements in PSTs' knowledge and attitudes. Moreover, PSTs with more positive attitudes toward CT also tend to possess higher CT skills (Cutumisu et al., 2021). Modules related to CT can expand PSTs' understanding and encourage them to integrate CT creatively across various subjects beyond mere computer use (Yadav et al., 2014).

However, the lack of real-world teaching opportunities remains a significant barrier that should be addressed in models for developing CT (Dong et al., 2024; Mouza et al., 2023). For instance, while elementary PSTs' teaching efficacy improved with courses incorporating robotics, Code.org, and puzzles, their self-efficacy in the outcomes of their teaching remained low due to the absence of actual classroom practice (Kaya et al., 2020). Field experiences can bridge this gap by helping PSTs connect theory with practice, which is critical for effective CS/CT integration into their educational practices. Another option is through school-university partnerships that have been highlighted as valuable for enhancing instructional skills by providing a realistic setting for PSTs to practice teaching (Mouza et al., 2023).

Importance of Field Experiences in Preservice Teacher Education

Research has documented the importance of field experiences in preservice elementary teacher education (Powell, 2019). Bridging educational theories and practices is a major objective, and field experiences serve as a critical method to achieve this goal (Coffey, 2010). Many preservice teachers enter education programs with fixed and traditional beliefs formed through years of observing their own teaching environments (Darling-Hammond, 2006; Richardson, 2003). However, field experiences have the potential to challenge these preconceived notions by providing authentic instances that contradict previous beliefs and help construct a new teaching identity (Butler & Cuenca, 2012).

Scholars have developed structured designs for field experiences to enhance their effectiveness for preservice teachers. Mediated field experiences in mathematics methods courses, for example, enable preservice teachers to recognize the importance of addressing students' individual needs and promoting inclusiveness (Horn & Campbell, 2015). Research comparing self-efficacy across a variety of field experiences suggests that embedded approaches—where content experts monitor the experience—can significantly improve preservice teachers' self-efficacy (McDonnough & Matkins, 2010). Similarly, redesigning field experiences to provide opportunities for preservice teachers to investigate children's reasoning and reflect purposefully on their teaching has resulted in more student-centered teaching practices and a better classroom culture compared to conventional field experiences (Amador & Galindo, 2020).

To be meaningful, field experiences require careful design. Despite an emphasis on reflective thinking in teacher education programs, preservice teachers often participate mechanically in field experiences, which can hinder their understanding (Hixon & So, 2009). Conflicting feelings arising when practices differ from their beliefs can also diminish the positive effects (Clift & Brady, 2005; Richardson, 2003). In experiences focused on technology integration, preservice teachers may feel discouraged when encountering technical issues (Lux et al., 2017). Therefore, structured field experience designs are essential to prevent negative impacts. Successful examples highlight the importance of preparation, small group observation, repeated practice, guidance from content experts, and reflection.

Research highlights the importance of field experiences in teacher education, especially in subjects like science where such experiences enhance PST self-efficacy and ability to connect theory to practice (Flores, 2015; Pryor & Kuhn, 2004). There is limited focus on field experiences specifically addressing CS/CT. The increasing demand for teachers proficient in CS/CT, underscores this gap and many elementary teachers lack formal training in CS/CT, which may lead to inequities in classroom implementation (Coenraad et al., 2020). Addressing this need requires preparing both in-service and preservice teachers to integrate CS/CT into their curricula through professional learning opportunities that combine CS/CT skills with effective pedagogical techniques (Ottenbreit-Leftwich et al., 2021).

This research focuses on what preservice teachers learn through a structured field experience designed specifically to teach CS/CT to early elementary students. By examining their learning through practical, embedded experiences, the study aims to understand how field experiences can enhance teaching competencies in the context of CS/CT. This approach seeks to ensure a more comprehensive and effective integration of CS/CT into elementary education, addressing the current gaps in teacher preparation.

METHODS

Research Methodology

To examine the learning that was reported by the PSTs, we utilized qualitative content analysis (QCA; Krippendorff, 2019), which allowed for the examination of concepts, skills, and ideas that PSTs reported following participation in a structured CT-focused field experience. Content analysis was selected as it can be utilized to construct meaning by making replicable and valid inferences from texts or other meaningful data sources. Collection of the PSTs teaching video reflections provided the opportunity for the participants to directly share their reality and for the researchers to obtain the language, feelings, and words of the participants as they reflected on this CT field experience. Using these data, QCA as a research method allowed for an in-depth analysis of the PSTs' learning during their field experiences through their own experiences and perspectives in order to answer our research question.

Conceptual Framework

This study is framed by intertwining constructivism, pedagogical content knowledge (PCK) development, and reflective practice. PSTs construct knowledge through authentic contexts related to their future practice, including actively engaging with young learners through social interaction, which facilitates co-construction of CT knowledge—both what CT is for the PSTs and the students and, for the PSTs, how to teach it (Powell & Kalina, 2009). This engagement begins to build the PSTs' PCK specific to CT by solidifying their CT knowledge while at the same time beginning to recognize with which concepts the elementary students are going to struggle (Shulman, 1986). Finally, reflective practice as couched within experiential learning is integral to this study as the reflection solidifies what they have learned and what they still need to explore or refine for the PSTs (Kolb, 2014). Together, these conceptual bases provide a backing to explore how PSTs learn to effectively integrate CT into their future classrooms.

Setting and Participants

The PSTs included in this study were a subset of 27 elementary PSTs enrolled in a three-credit introductory educational technology course during their first year at a Midwest public university. As part of the coursework, CS/CT is covered in a four-week unit that engaged PST in unplugged and plugged activities with robots and digital devices and ended with the CT related field experience. As part of a partnership with a local school district, elementary students traveled to the university campus and participated in two different CS/CT activities in small groups that were taught by the PSTs enrolled in the educational technology course. The PSTs signed up for a half-day teaching experience at their Midwestern university as part of their coursework and were responsible for teaching one of two CS/CT lessons to a small group of elementary students. PSTs were provided with a field trip handbook that included both lesson plans and were strongly encouraged to look over and familiarize themselves with the lessons before they taught the lessons to elementary students. On the field experience day, before beginning their teaching sessions, the PSTs were led through a modeled session of both lessons by the researchers. In addition, there was a 30–45-minute preparation time for preservice teachers to explore and practice with the resources for the activities (ScratchJr or Tale-Bot). There were two rotations to allow the elementary students to experience both CS/CT lessons. Each PST taught the lesson twice to two different small groups of elementary students. Following the teaching of their lessons, the PSTs were asked to submit a video reflection on their experience to the course management site as part of their assignment for the course. It is important to note that the teaching and video reflection was submitted as part of the coursework which might have limited the extent to which the PSTs were open and honest when reflecting on their experience.

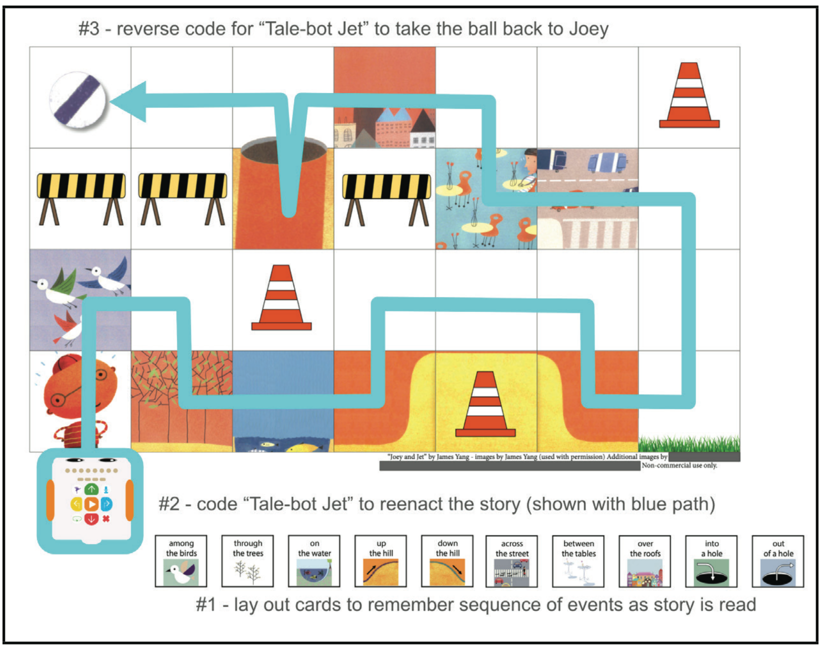
The two CS/CT tools that the PSTs could choose from were Tale-Bot and ScratchJr. Both were integrated with literacy as part of the task. Tale-Bot is a push-button robot that allows users to 'code' its movements by pressing arrow buttons located on the top of the device. It features lights that display the code as it is being created and during execution, providing real-time feedback that matches the robot's current movement with the programmed commands to assist in debugging. ScratchJr is a tablet-based app that allows users to control the movement of a character on the screen using block coding. When the code is executed and the character moves, the corresponding block code is highlighted in sync with the character's actions to assist in debugging. The following describe the two lessons the PSTs could choose from:

Lesson #1: Joey and Jet with Tale-Bot

This lesson targeted sequencing within a story using “Joey and Jet” by James Yang. The book presents a fetch game from a dog’s perspective, aiding elementary students in understanding sequencing, reverse sequencing, and preposition words. The lesson began with the PST reading the story aloud and then pausing for the elementary students to place picture cards on the table in the order in which the dog Jet’s actions occurred to help the students remember the order of events. Then the students were asked to code the Tale-Bot, who represents the dog character Jet, to travel along a large mat with pictures from the story in the correct order to go from Joey to the ball (Figure 1).

Figure 1

Order in Which Students Worked through the “Joey and Jet with Tale-Bot” Lesson



Lesson #2: After the Fall in ScratchJr

In this second lesson, students worked on sequencing with multiple logic paths using the application ScratchJr on an iPad. This lesson also has a literacy component using the book “After the Fall: How Humpty Dumpty Got Back Up Again” by Dan Santat to set the context for the ScratchJr activity. After the PST read the story aloud, students identified the beginning, middle, and end of the story from the perspective of the main character (Humpty). Then the PST introduced the ScratchJr app to students before asking the students to complete a graphic organizer to plan out codes for each part of the story (Figure 2 below). Students then opened a ScratchJr template file with the characters and background of the story. They used this template to retell the story by coding the actions of Humpty with a beginning, middle, and end slides to represent three parts of the story.

Figure 2

Graphic Organizer for the After the Fall in ScratchJr. Lesson

From the larger group, we selected 13 PSTs to teach the Tale-Bot lesson and 14 PSTs to teach the ScratchJr lesson. They were assigned based on preference first, but a few who said they did not really have a preference were assigned to make the PSTs numbers nearly even. These PSTs agreed to participate in the research study and taught small groups of students who, with parental consent, also agreed to participate.

Data Collection and Analysis

Data collection included video recordings of the PSTs teaching the CS/CT lessons with elementary students and video reflections from the PSTs that were uploaded to the course management site following their experience. As the focus of this study was on the PST's views on learning following participation in a CT field experience with elementary students, the video reflections were the main source of data for this content analysis. Each of the PSTs were asked to complete the following assignment for their videotaped teaching reflection:

> *Create a 4–5-minute screencast video reflection of your field experience. Prepare several slides for your screencast with words (not too many words!) and images to help others understand your experience: set the scene for us, tell us about the setting, the students, and the activity/activities you observed or participated in. Do NOT include images of students that are identifiable.*
>
> - *In your screencast, answer the questions below that are applicable to your experience:*
> - *Describe the students - age, engagement level, and any other interesting observations you made.*
> - *Describe the lesson or learning experience. Was the instruction more teacher-centered or more student-centered? Explain why.*
> - *Did you see evidence of the teacher engaging students? Did students explore? Did students apply what they learned? Or reflect? Or share with others?*
> - *What technologies were being used 1) by the teacher; and 2) by the students Were these technologies for productivity? Consumption? A creative activity?*
> - *What did you learn and/or how will this contribute to your own professional identity as a teacher?*

Following the tenets of content analysis (Krippendorff, 2019), each of the video reflections were transcribed to provide a written representation in addition to the videotaped reflection. To help ensure a systematic and replicable analysis process, all members of the research team familiarized themselves with the two lessons and the reflection prompts prior to starting any coding of the data. Four members of the research team worked together to develop initial codes from the PST video reflections and transcripts through a process of examining, discussing, and modifying to help ensure that there was a common understanding of the codes, that each coder was identifying similar concepts, that the coding represents intended concepts, and there was no overlap between the concepts. The use of multiple coders viewing the same data helps to check for reliability and ensure that the analysis represents the identified concepts from the data. Following these discussions, the research team developed a codebook (see Table 1) that was used during analysis of the video reflections.

Table 1

Themes, Codes, Assertions, and Example Quotes

Theme	Codes	Example Quotes
Student Engagement	Excitement, enthusiasm, interest, active participation, persistence, hands-on	The lesson was more student-centered because it was hands-on which made the engagement level a lot higher and enhanced the lesson because anytime something's hands-on, I feel like kids like to consume it more, so it just makes it more versatile for different types of students. (PST # 21)
Student Empowerment	Student ownership, applying their ideas, exploring on their own, sharing ideas	This was definitely more of a student-centered project because the students would kind of mess around and explore with Scratch and kind of do what they want with their own creative process which was really cool. (PST #8)
Management	Teacher guidance vs. student independence, keeping on task, student needs, differentiation	They got a little bit off track because they wanted to make Humpty Dumpty do something fun or spin around 88 times …um it took a lot of redirection on my part… but they ended up doing it and had a lot of fun. (PST #14)
Flexibility and Adaptability	Adapting teaching strategies, responding to student needs and challenges, modifying the lesson	What I learned is that each lesson will have things that go wrong, and I can tweak it for the next group of students…. I just learned how to be flexible, and that's definitely a very important characteristic that I will need in the future. (PST #20)
Self-efficacy	Self-efficacy in teaching, CT and working with students, activities and relevance for future	When I first walked in, I was nervous and not prepared to teach computer science, but once I learned and became familiar, I was so excited to teach the younger students how to learn and become passionate about the new technology. (PST #12)

Following creation of the codebook, the research team continued with analysis of the video reflections and transcripts using the codebook. Two members of the research team used the codebook to code all 27 of the PST teaching reflections and the additional two members each coded half of the reflections. The resulting codes from each coder for each PST reflection were reviewed, discussed and agreed upon before they were chunked into groupings representing similarities, patterns, or relationships across the data. The results from the coding and analysis led to the emergence of themes about the PSTs experiences and what they learned as a result of the CT-focused field experience that will be shared in the next section.

RESULTS

When examining how to better prepare elementary PSTs to effectively integrate CS/CT into their future classroom instruction, elementary PSTs were presented with opportunities to practice and reflect on their teaching of CT to small groups of elementary students during a structured CT-related field experience. Analysis of the PSTs' teaching reflections across the two CT lessons, resulted in the emergence of the following themes related to the learning and experiences of the PSTs: (a) *recognition that hands-on activities and technology integration leads to K–2 student engagement,* (b) *identification of the importance of students taking an active role in their learning,* (c) *acknowledgement of the importance of flexibility and balancing guidance with independence during teaching,* and (d) *improved self-efficacy in implementing CT activities in the future*.

Hands-on Activities and Technology Integration Leads to K–2 Student Engagement

When asked to reflect on the students and lesson, 23 of the 27 PSTs reported that the CT lesson and the use of the technology made it hands-on for the students, which enhanced student engagement. Out of the two groups, 12 from the ScratchJr group and 11 from the Tale-Bot group made mention of this in their reflection with eight mentioning it more than once. Several PSTs referenced that allowing students to directly interact with block-based coding (Scratch) or the robots (Tale-Bot) led to more student-centered lessons, which increased enthusiasm, participation, and persistence. One preservice teacher remarked, "instruction was definitely more student-centered as it was a very hands-on experience. The kids got to interact with the robot, the iPads, and they showed a lot of enjoyment... it (the lesson) took a long time, but they stayed engaged" (PST #22). 22 of those 23 reflections echoed this sentiment, noting that the tactile, interactive nature of the tasks kept students engaged, often pushing them to explore the material beyond the lesson's immediate requirements. For example, one preservice teacher said, "The students were very engaged and enthusiastic. They would often get ahead of the lesson just because they really wanted to do all of the steps" (PST #7). Another noted that "what I learned was that students like to be very hands-on, and they learn a lot better when they get to do things with their hands and like do these cool coding activities—at least I think they're really cool and interesting—and I think that they have a lot of fun with it as well as it being an educational tool" (PST #4). Nine of the PST reflections also mentioned that they thought the use and integration of the technology was engaging for students. For example, one PST stated that "the students used iPads to code what they learned in the story, and this was a way to connect computer science and literacy. These technologies were used to engage the students … to engage and apply what they learned in the story while also learning how to code. (PST #12)"

Students Taking an Active Role in Their Learning is Powerful

In addition to mentioning that the elementary students appeared engaged in the activity, 17 PSTs expanded on this idea further with comments describing how the K–2 students were exploring and taking charge of their own learning during the CT (sequencing) activities. They realized how student-centered design within the structured lessons was important to empower students to take an active role. One PST reflected that, "Teachers still had control of the lesson reading the story and knowing the code patterns, but the students were in control of their individual projects and could experiment with it in whatever way that they wanted" (PST #14).

Also, eight PSTs noticed and commented on how the K–2 students could take ownership of their own learning and have the competence to do it. One PST mentioned, "I found that they didn't really need me as much as I thought… The instruction itself was very student centered… The kids were very happy and lively, and they were excited to be there applying the lesson" (PST #13). Five PSTs reflected that their students experienced numerous trials and errors to discover the correct codes and solutions but persisted in the task. One PST stated that, "What I loved about each and every kid was that they were willing to try again, and they didn't give up, which was a very nice quality that all of them did share" (PST #5). Also, another PST said, "The students applied what they learned through trial and error… If the code didn't work, they would have to change the code to see what works and what doesn't work. They were able to try new things that way" (PST #9). Another five PSTs mentioned that the lessons allowed for and promoted creativity, which allowed the students to use different features of the app or robot and their own ideas in their solutions. Overall, PSTs from both groups noted that in addition to the elementary students being engaged, the students were able to take an active role in their own learning.

Importance of Teacher Flexibility and Balancing Guidance with Independence

Several ideas related to instructional practices, differentiation, and classroom management emerged as the PSTs reflected on their small group lessons. 10 PSTs made comments related to management and that balancing teacher guidance with student exploration during their teaching was important because it allows the students to have some independence and ownership to be creative but not to go too far that they get off-task (PST #12). PST #8 reflected that "one thing was just keeping the kids on task, they got it so quickly, so they wanted to make new projects. They wanted to make other stuff on the Scratch app so that was also really cool to see them making projects." Another PST noted that, "they got a little bit off track because they wanted to make Humpty Dumpty do something fun or spin around 88 times …it took a lot of redirection on my part… but they ended up doing it and had a lot of fun" (PST #14).

Over half of the PSTs (15) also recognized that different strategies were needed for different students and groups. For example, one PST mentioned that "One of my key takeaways is that what works for one group of students or what works for one student individually is not going to work with both groups or with every student" (PST #18). Also, that flexibility and being able to adapt their teaching were important when lessons did not unfold as planned. All 15 PSTs reported learning how to adjust content and/or delivery methods to better suit the needs of the students in their group. One preservice teacher stated,

> The third student, he was less enthusiastic. And so, in that, in that case, it was more of okay, adapt the lesson to him. So, it became kind of, "Oh, would you like to program

> your tablet, or would you like to just explore?" And so, in that way, he's still getting the access to the technology, and can kind of understand how the technology works. (PST #16)

Another six PSTs reflected on the need for being flexible or adaptable in their teaching as seen in this example, "What I learned is that each lesson will have things that go wrong, and I can tweak it for the next group of students…. I just learned how to be flexible, and that's definitely a very important characteristic that I will need in the future" (PST #20). Overwhelmingly, the preservice teachers recognized the importance of being responsive to students' needs and demonstrated increasing self-efficacy in their ability to be flexible when teaching. Several PSTs also noted that factors such as group dynamics and time of day influenced student focus. One preservice teacher observed that social factors played a role in engagement, stating, "The first group wasn't as enthusiastic as the second group, and I would say that's because the first group weren't friends with each other" (PST #7). Even with these occasional challenges, most PSTs found that the hands-on approach and the use of technology to support that approach was effective in maintaining student interest and promoting active participation in the CT lessons.

Self-efficacy in Implementing CT Activities

Based on PSTs reflections, this structured field experience increased preservice teachers' self-efficacy in implementing CT activities and their application to the future. 19 of the 27 PSTs reflected on how this experience improved their self-efficacy in teaching and working with students and 16 of those mentioned that they had more self-efficacy implementing and integrating CT activities and technology in the future. For example, one PST mentioned:

> When I first walked in, I was nervous and not prepared to teach computer science, but once I learned and became familiar I was so excited to teach the younger students how to learn and become passionate about the new technology we would be incorporating. (PST #12)

Another PST made a reference to the fact that "as a future educator this field experience made me so excited to have my own students and teach and to teach one day" (PST #23).

Additionally, 17 PSTs reflected on the fact that these lessons and experiences would have future applications to their teaching careers. With one student mentioning, "I realized that I can pair computer science lessons with other lessons that I've created and need to teach, because this was literacy and computer science, so there's a lot of crossover that I could do" (PST #9). Another student mentioned that "There are many ways to incorporate technology into the classroom, and I wouldn't have initially thought of using a story and sequencing with a Tale-Bot to teach coding. I found this very interesting and learned a lot overall" (PST #27).

Overall, the PSTs recognized that the use of hands-on, active learning with technology like the Tale-Bot robot or the ScratchJr app on an iPad led to increased student engagement while also providing the students with an opportunity to take ownership of their learning. Additionally, this structured field experience contributed to the PSTs' professional growth as the PSTs acknowledged the importance of balancing independence with teacher guidance and a need to be flexible and adaptable during the teaching of these activities as the students and groups had different needs and abilities. Finally, several PSTs made remarks that the actual teaching of these activities with real students not only helped them to better understand how to teach elementary students in the future, but it also enhanced their self-efficacy in teaching CT/CS. These findings highlight how such learning experiences can teach PSTs about student engagement, empowerment, and technology integration, while also enhancing PSTs' self-efficacy and adaptability in teaching CT to elementary students.

DISCUSSION

This study contributes to the growing literature on preservice teacher preparation in computational thinking by demonstrating the essential role of structured field experiences in developing PSTs' self-efficacy and pedagogical adaptability. While prior research has emphasized the importance of embedding CT into coursework and teacher training programs (Dong et al., 2024; Yadav et al., 2014), our findings extend that work by highlighting that direct engagement with teaching CT to elementary students provides a critical opportunity for PSTs to apply, refine, and reflect on their teaching. The structured field experience provided a space for PSTs to build knowledge and self-efficacy in integrating CT and technology into lessons, which is important as elementary teachers often lack the knowledge and self-efficacy to integrate CT into their classroom (Rich et al., 2019; Rich et al., 2021). Prior research suggests that teacher preparation programs should address elementary teachers' lack of self-efficacy in teaching CT/CS (Ottenbreit-Leftwich et al., 2021), our findings extend this work suggesting that structured field experiences, where PSTs directly engage in teaching CT, could be a pathway to improve PSTs self-efficacy and ability to implement CT activities.

Additionally, participants reported increased self-efficacy when integrating CT into future instruction, particularly in balancing student-centered learning with structured guidance, which supports previous studies highlighting the effectiveness of hands-on, inquiry-based approaches in CT education (Israel et al., 2015; Rich et al., 2019). These findings illustrate how exposure to CT instruction with actual students in a real-world teaching experience fosters adaptability, as PSTs navigated challenges related to student engagement, instructional pacing, and differentiation—issues frequently cited as barriers to effective CT integration (Mouza et al., 2017; Yadav et al., 2014). These results also align with research on the role of reflective practice in teacher learning, as PSTs' video reflections demonstrated how structured opportunities to teach and then critically analyze their experiences helped them refine their pedagogical strategies (McDonnough & Matkins, 2010).

As with any study, certain limitations should be acknowledged. First, the relatively small sample size of 27 preservice teachers may limit the generalizability of the findings. While the results offer valuable insights into the experiences of these PSTs, future studies with larger sample sizes would provide more robust data. Additionally, the context of the field experience, which was embedded within a specific educational technology course at a Midwestern university, may limit the applicability of the findings to other settings. Future research could explore the replication of this field experience model in different geographic regions or educational contexts to determine the extent to which the findings hold across diverse populations.

IMPLICATIONS FOR TEACHING PRACTICE, RESEARCH, AND POLICY

The findings from this study reinforce the critical role of incorporating structured field experiences into teacher preparation programs to prepare PSTs to effectively integrate CT in their future classrooms. Structured field experiences in CT enhanced preservice teachers' self-efficacy, adaptability, and pedagogical skills by fostering student engagement, encouraging active learning, emphasizing flexibility in instruction, and reinforcing the integration of technology in elementary classrooms. These findings hold important implications for teaching practice, future research, and educational policy.

Our findings highlight the critical role of structured field experiences in bridging the gap between theoretical coursework and real-world teaching, demonstrating that gradual exposure and hands-on practice significantly improve PSTs' self-efficacy in CT instruction. Many PSTs initially lacked confidence in teaching CT, yet we saw that their engagement in structured classroom interactions with elementary students increased their instructional confidence and their recognition for pedagogical adaptability. To support this, teacher preparation programs should embed CT-focused field experiences into their curricula, leveraging school-university partnerships to provide authentic teaching opportunities in either K–2 classrooms or university-based outreach programs. A CT-related field experience can provide PSTs with important opportunities to practice and wrestle with pedagogical issues that are common when working with elementary students, especially when integrating technology and CT into lessons. Bringing the K–2 students to campus helped mitigate issues and concerns associated with finding teaching placements and travel for our PSTs to allow for real-world teaching. This field experience model, utilizing a local school coming to campus, provides an opportunity for a larger number of PSTs to work directly with elementary students as this model involves participation of an entire grade level with three classrooms and approximately 75 students per visit. Through these field trip teaching experiences, programs can better equip PSTs with the practical skills and pedagogical self-efficacy necessary for effective CS/CT instruction. The integration of these experiences, alongside traditional coursework, will help bridge the gap between theoretical knowledge and practical application, thereby enhancing overall teaching efficacy in CT where elementary teachers often feel under-prepared.

Additionally, this study reinforces the need for scaffolded learning approaches in teacher preparation, where PSTs transition from observing effective CT instruction to peer teaching and finally to leading lessons with elementary students. Another key implication is the PSTs recognition of the importance of student-centered learning, as PSTs observed that young learners engaged more deeply when they had ownership over their learning, explored coding concepts independently, and engaged in creative problem-solving. These findings suggest that teacher educators should not only model inquiry-based instructional strategies that emphasize active learning and student agency in computational thinking activities but also reinforce that learning with real world CT teaching experiences.

While the immediate benefits of the field experience are clear, the potential long-term impact on PSTs' teaching practices should also be noted. The opportunity to engage with CT activities early in their teacher education journey likely contributes to a foundational shift in their approach to technology integration and problem-solving in the classroom (Coffey, 2010). As they transition into inservice teaching roles, these early experiences may empower them to continue exploring new and innovative ways to engage students with CT and CS concepts. Additionally, their increased self-efficacy in teaching technology-related subjects may inspire them to advocate for the inclusion of these topics in their future classrooms, potentially influencing broader curricular decisions at their schools. Future research should explore the long-term impact of structured field experiences on PSTs' teaching practices, particularly whether the gains in self-efficacy and pedagogical adaptability observed in this study persist into their in-service years. Longitudinal studies tracking PSTs as they transition into full-time teaching roles could determine whether early CT field experiences lead to sustained instructional confidence and deeper integration of CT in elementary curricula. Additionally, the role of mentorship in supporting PSTs remains underexplored; future research should examine how mentor teachers' modeling of CT instruction, feedback, and co-teaching experiences influence PSTs' development and comfort with integrating CT. Investigating different mentorship models, such as expert coaching, peer mentorship, or co-teaching, could offer valuable insights for teacher preparation programs. Another critical research direction is examining student learning outcomes in PST-led CT lessons, as this study primarily focused on PST experiences rather than how CT instruction impacts elementary students' engagement, problem-solving abilities, and coding proficiency. Finally, research should explore the scalability of structured CT field experiences across all types of teacher education programs. Comparative studies across multiple universities could identify best practices for expanding access to CT field experiences while addressing concerns regarding the lack of opportunity in CT instruction.

Policy changes are essential to ensure CT is effectively integrated into elementary education through teacher preparation, curriculum development, and educational statutes. While CT is included in many states at the K–12 level, state governments should mandate CT training as part of elementary teacher certification—requiring coursework and field experiences to equip all new educators with the skills to introduce and integrate CT concepts. Additionally, funding should support school-university partnerships that provide structured CT teaching opportunities, as many institutions lack the resources to implement these experiences at scale. Finally, funders should incentivize collaborations between higher education and K–12 schools to enhance both PSTs and student exposure to CT experiences.

CONCLUSION

This study highlights the importance of structured field experiences in PSTs to integrate CT into elementary education. Through hands-on teaching and reflection, PSTs gained self-efficacy, adaptability, and confidence in CT instruction, bridging the gap between coursework and classroom practice. They recognized the value of student-centered learning, inquiry-based pedagogy, and flexible instructional approaches in fostering engagement with CT. These findings emphasize the need for CT-focused field experiences in teacher preparation and continued investment in school-university partnerships to provide authentic teaching opportunities. Ensuring that PSTs enter the field with hands-on experience in CT will help build a generation of educators equipped to integrate technology-driven learning into elementary classrooms.

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