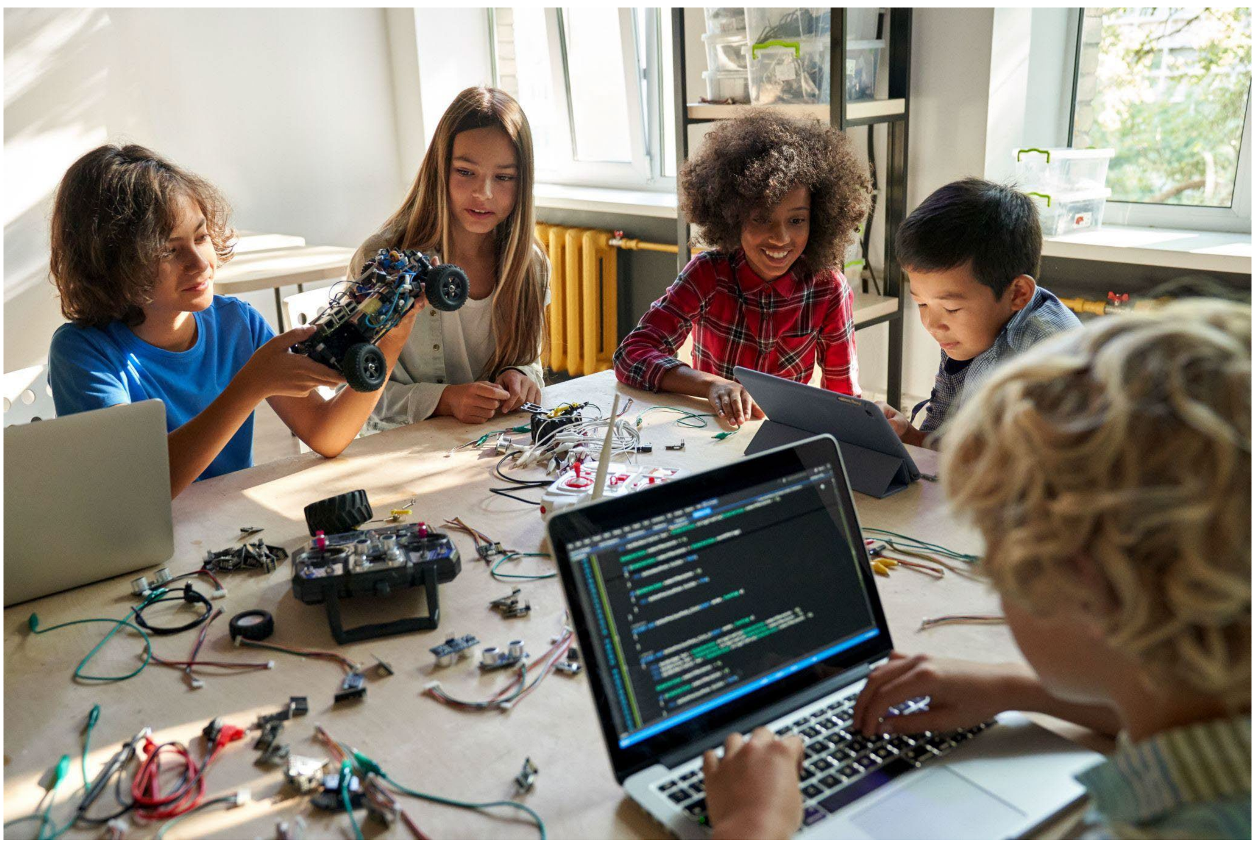
Needs Analysis Report: Building Indiana Computing Capacity (IC2) for Preservice Computer Science Education

Indiana University Bloomington, July 2024



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Executive Summary

The purpose of this needs analysis was to assess the current state and needs of Elementary Preservice Teacher Preparation Programs in Indiana concerning the preparation of teachers to instruct in Computer Science (CS). This report summarizes the methods used to collect and analyze the data and provides evidence-based recommendations. The key findings and recommendations are listed below.

Key Findings

- No stand-alone CS courses or certification programs are offered in participating Elementary Preservice Teacher Preparation Programs. CS is integrated or included in the existing courses.
- Faculty use free and available resources or create their own course activities focusing on CS.
- Providing CS-related field experiences offers authentic CS learning and teaching opportunities.
- The existing challenges are as follows:
    - faculty awareness and preparedness to teach CS in their elementary preservice teacher preparation programs;
    - lack of quality Introductory CS courses available for preservice teachers;
    - access to and collaboration with elementary schools to provide field experiences that model CS instruction;
    - administrative support for providing CS experiences across the courses and curriculum in the teacher preparation program.

Recommendations

1. Integrating CS in methods courses is a common way to address CS standards and provides opportunities for preservice teachers to be introduced to teaching CS in elementary grade levels.
2. Creating environments for preservice teacher educators, and faculty members, to learn CS, and access professional development and other resources can improve the implementation of CS and CS standards into their Elementary Preservice Teacher Preparation Programs.
3. Collaborating with in-service teachers helps offer preservice teachers real-world learning opportunities through field experiences and student teaching practicums. This will improve preservice teachers' competencies in implementing CS standards in their future classrooms.

Acknowledgments

We would like to begin this needs analysis report by expressing our gratitude to all those who contributed their time, energy, and guidance to make this project possible. First and foremost, we thank all representatives of elementary preservice teacher education programs in Indiana who responded to the survey and those who took time and participated in the interview phase of the analysis and shared their CS teaching resources. We acknowledge their voluntary participation regardless of their busy schedules. Their experiences and insights were integral to this needs analysis.

We would also like to acknowledge our team members whose hard work and dedication helped complete the analysis and made the entire Building Indiana Computing Capacity (IC2) for Preservice Computer Science Education project possible. Our team members are Dr. Anne Leftwich, Dr. Thomas Brush, Dr. Cindy Hmelo-Silver, Dr. Kyungbin Kwon, and Dr. Susan Drumm, as well as graduate research assistants Dilnoza Kadirova and Lin Chu. Their dedication and openness to learning about implementing Computer Science in Elementary Preservice Teacher Education Programs served as the driving force behind this needs analysis.

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Introduction

Over the past several years, K-12 Computer Science (CS) education has been undergoing a transformation which has resulted in the expansion of the focus on CS training and professional development (PD). As more states adopted CS standards to their elementary and middle school curricula, the need for providing PD to all teachers and preparing them to teach CS increased (Mason & Reach, 2016; Milliken et al., 2019, Ozogul et al., 2018, Pollock et al., 2017; Ravitz et al., 2017; Scanlon & Connolly, 2021, Yadav et al., 2013). Providing these opportunities has become especially important for teachers in elementary schools, where CS concepts need to be integrated into existing content and curricula (i.e., is not offered as a separate class taught by CS-licensed teachers).

To increase the capacity for elementary school teachers to teach CS, it is important to provide training opportunities for pre-service teachers (Lang et al., 2013, as cited in Ozogul et al., 2018). Thus, several teacher education programs in Indiana have recognized the need to equip future educators with the knowledge and competencies necessary for them to teach CS. In this needs analysis we sought to gain additional insights regarding how various Elementary Preservice Teacher Preparation Programs are teaching and integrating CS into their teacher education programs and curricula.

Aim and Scope

This needs analysis addressed how Elementary Preservice Teacher Preparation Programs approached teaching CS and what challenges they faced. We hope that the findings of this analysis will contribute to better understanding and the further development of CS components in teacher preparation programs. This report includes detailed analyses of survey responses, interviews, and resources utilized to teach CS. In addition, this report discusses the challenges identified by teacher educators, which can inform and guide programs, faculty members, and other stakeholders that are involved in preservice teacher CS education and professional training. As one of the pillars of the Building Indiana Computing Capacity (IC2) for Preservice Computer Science Education grant project, which aims to expand the preparation of well-equipped preservice teachers and their educators in the knowledge and competencies of CS for K-12 education, this needs analysis can provide insights into current opportunities for teaching CS and the capacities existing within teacher preparation programs in the state.

Method

Before we started collecting data for the needs analysis, we identified all Elementary Preservice Teacher Preparation and Certification Programs in Indiana. Initially, we used the list of contacts provided on the Indiana Department of Education (IDOE) webpage. Then, we examined program webpages and information sheets and contacted representatives of the programs, which helped us to confirm our list of contacts. After we identified faculty members and representatives of the programs, we emailed them with the request to participate in the needs analysis. We also included a link to the online needs analysis survey and requested that they complete the survey (or forward the survey link to the individual who was most knowledgeable about their elementary teacher preparation program).

Survey Participants

Initially, we contacted 102 representatives of 53 programs. We expanded our contact list and included 13 more representatives of 12 programs, for 115 contacts from 65 Elementary Teacher Preparation Programs across Indiana. We received 30.4% of the response rate to the needs analysis survey. In addition, 19 faculty members agreed to participate in follow-up interviews to obtain more detailed information regarding their programs. Those faculty members were emailed with the details for scheduling an interview.

Interview Participants

Of those 19 faculty members who initially expressed interest in participating in a follow-up interview, we were able to schedule interviews with nine faculty members who represented six Elementary Preservice Teacher Preparation Programs in the state. A majority of interviewees represented four-year teacher certification programs. See Table 1 and Table 2 for the interview participants' details and information about their programs. Pseudonyms were used to ensure the protection of participants' confidential information, and the institutions were coded.

Table 1

Program Details

Programs	Interview Code	Length of the Program	Number of Preservice Teachers Completing the Program Annually
Program A	A01	4 years	18-25

Program B	B02, B03	4 years	80-85
Program C	C04	4 years	35-40
Program D	D05	4 years	50-70
Program E	E06	2 years	25
Program F	F07, F08	2 years	30

Three of the participating programs had two representatives interviewed. In total, there were eight interviews conducted, and in one of the interviews, two faculty members were present at the same time. Each one of their responses was coded separately. Among nine faculty members, five of them held leadership positions at their institutions and programs. Most of the faculty members reported the courses they taught and five of them shared with us their instructional resources.

Table 2
Participant Details

Interview Code	Pseudonyms	Positions Hold	Courses Taught
A01	Armani	Assistant Professor Program Director	Math and Science Methods
A01	Azure	Assistant Professor	Teaching Methods
B02	Bellamy	Assistant Professor	Technology Integration
B03	Brighton	Professor Department Chair	N/A
C04	Casey	Associate Professor Director of Graduate Studies	STEM
D05	Dillon	Professor	Science and Technology
E06	Easton	Program Chair	N/A

F07	Forest	Department Chair	N/A
F08	Golden	Faculty member	Technology Integration

Data Sources

Survey

The link to the survey was sent via email to all 115 representatives of Elementary Preservice Teacher Education Programs in Indiana. The survey was anonymous, and we did not collect any identifiable information such as names or institution affiliation. Respondents could only identify themselves if they chose to share their resources or agreed to be interviewed. The survey was relatively short, and the questions were created in a logical order depending on their responses to the first question the participants were given six, four, or two more additional questions. Please refer to Appendix A for a copy of the survey instrument.

Interviews

Based on the 19 positive responses to the question in the survey regarding participation in the interview phase of the analysis, we invited Elementary Preservice Teacher Education Program representatives to schedule interviews with our team members. As a result, we conducted eight interviews with nine faculty members and representatives of leadership of six programs. All interviews were conducted virtually via university Zoom video conferencing call. With the permission of the participants, the interviews were recorded for further analysis.

We used a semi-structured interview protocol, and each interview lasted about 30 - 40 minutes. At the beginning of each interview, participants were provided with the definitions of CS and Computational Thinking (CT). The definitions of concepts and practices provided were based on the K-12 Computer Science Education Framework (K-12 Computer Science Framework, 2016), and the Operational Definition of Computational Thinking for K-12 from the International Society for Technology Education (ISTE) (ISTE, 2024). The interview questions focused on teaching and integration of CS/CT, as well as the description of elementary preservice teacher programs, courses, and resources. In addition, questions related to barriers when teaching and integrating CS/CT were also included. Please refer to Appendix B for a copy of the interview protocol.

Resources

The needs analysis survey included an opportunity for respondents to share their syllabi and resources if they chose to do so. They were given the option to either attach the resource(s) to their survey response or email the resource(s) directly to the research team. We received one syllabus from one of the participants who emailed it to our team. The same participant also provided us access to their teaching module focusing on CS. In addition, we asked the interview participants to share their resources with us. Four more faculty members provided us with their instructional resources (including syllabi, activities, and slides). Table 3 provides more detail regarding the resources provided by participants.

Table 3
Resources

Programs	Types of Resources
Program A	assignment sheet and instructional material (slide deck), activity sheet
Program B	syllabus and module
Program C	syllabi (two courses)
Program D	instructional material (slide deck), activity sheet
Program F	tentative agendas (two courses)

Data Analysis

After collecting the survey data, we summarized the results using descriptive statistics. We also analyzed the open-ended responses for additional insight to support the results of the descriptive statistics. Thematic analysis was used to interpret the results of the interviews (Clarke & Braun, 2017). Specifically, we implemented a deductive approach to the analysis. The memos were used to compare and triangulate findings from the interview. Any discrepancies were addressed by verifying the data source's accuracy and consulting with team members. Finally, we conducted a content analysis of the resources to provide additional information regarding the types of activities and content utilized to teach CS and CT concepts.

Findings

The findings section of this report is presented in three sections: survey results, interview themes, and resource observations. They can be found under the designated headings. Further discussion of the findings is presented in the conclusion section.

Survey Results

Out of 115 faculty members and representatives of Elementary Preservice Teacher Education Programs in Indiana, we received a 30.4% response rate and a 68.5% completion rate. Overall, 35 participants started the survey, and 24 completed it. Table 3 shows the details regarding the survey responses and completion. Among the 24 responses received, 18 indicated their programs incorporated Indiana K-8 CS standards, five stated they did not, and one respondent was unsure (Figure 1). In the following sections of the report, we presented the survey results in two major categories 1) Indiana K-8 CS Standards Covered and 2) Indiana K-8 CS Standards Not Covered or Unsure. The categories mirror survey sections and questions. Each category consists of subcategories.

Table 4

Survey Responses

Invited	Started	Completed	Response Rate	Completion Rate
N=115	N=35	N=24	30.4%	68.5%

Figure 1

K-8 CS Standards Covered

Notes. Result of whether the programs covered Indiana K-8 CS standards (N=24)

Indiana K-8 CS Standards Covered

For the 18 faculty members who responded that their programs are implementing Indiana K-8 CS standards, we further investigated whether the standards were required for their students to complete as a part of their training, how the standards were covered in their programs, what kind of curriculum resources they included, and what barriers they encountered.

Required for Program Completion: Although the 18 faculty members expressed that they covered Indiana K-8 CS standards in their programs, not all stated that those courses were required for the preservice teachers to complete as a degree requirement. This suggests that some of the courses that included Indiana K-8 CS standards might be optional in some Elementary Teacher Education Programs. To summarize, 15 faculty members indicated that courses covering Indiana K-8 CS standards were required for the preservice teachers. Two faculty members replied "no" to the question, and one was "unsure" (Figure 2).

Figure 2

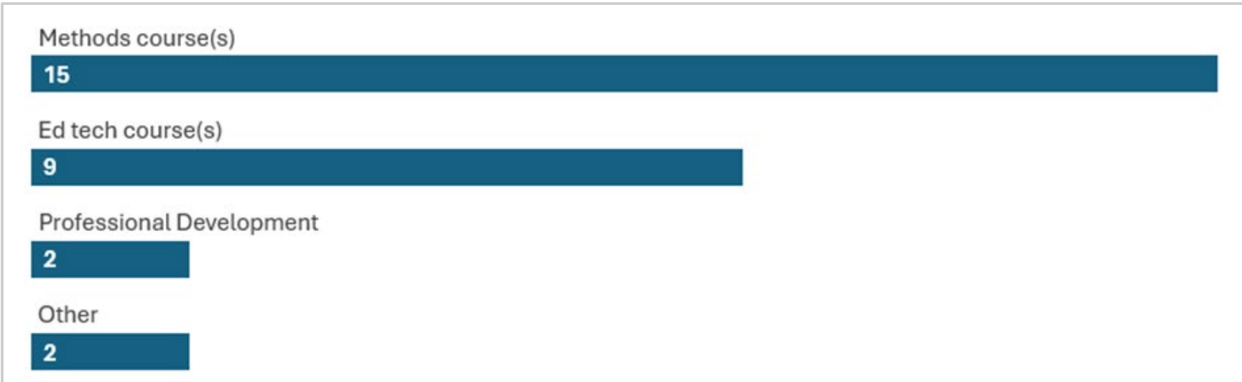
Standards Required

*Notes***.** Results of whether the standards were required for their students to complete as a part of their training (N=18)

Covering CS Standards: Among the 18 faculty members, 15 indicated that their programs covered Indiana K-8 CS standards in the methods course(s), such as Science (n=13, including Introduction to Engineering and STEM), Math (n=5), English-Language Arts (n=2), Social Studies (n=2), Assistive Technology (n=1), and Development Psychology (n=1) (Figure 3).

Figure 3

How Standards Were Covered



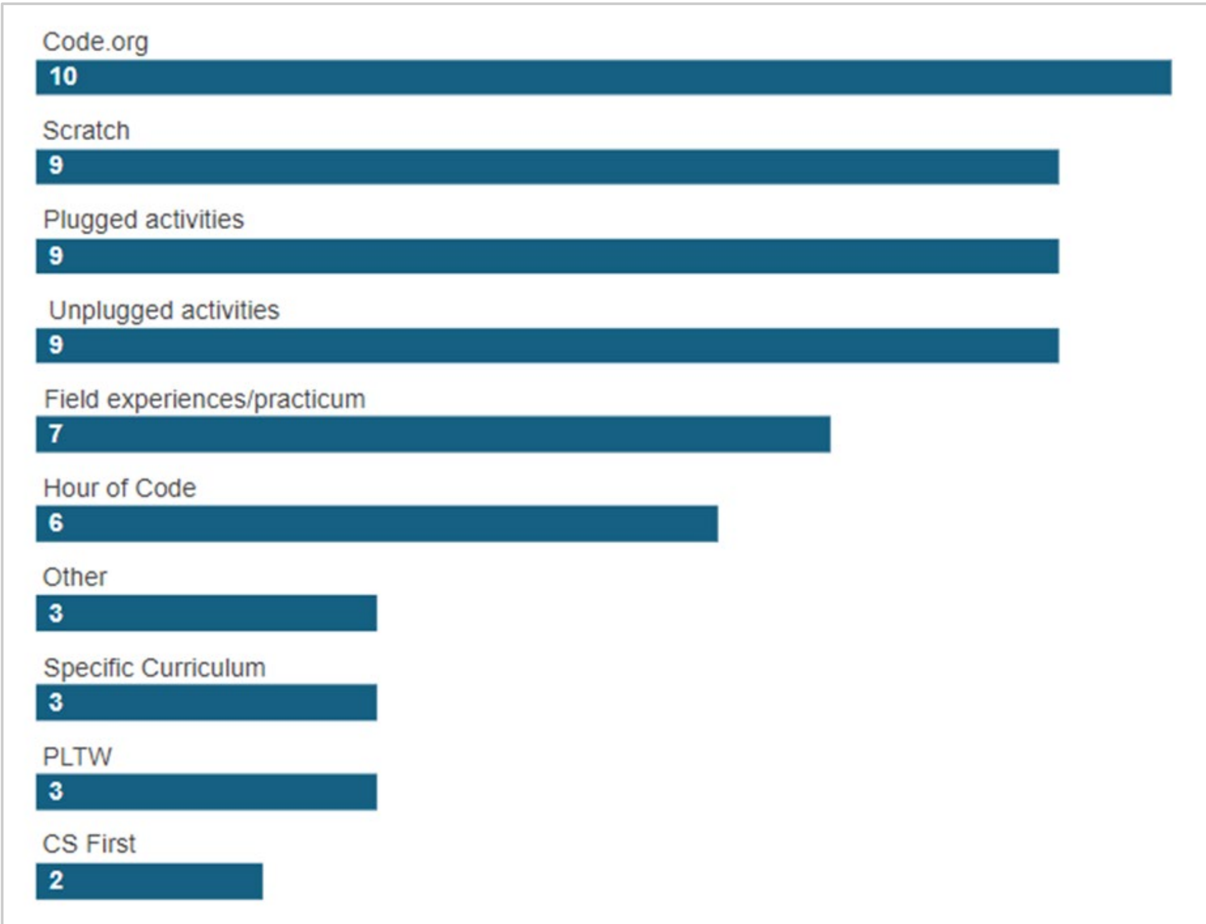
Notes. Results of how the standards were covered in the programs (N=18)

The standards were also covered in Ed tech course(s) (n=9), professional development (n=2), and other opportunities such as Introduction to Teaching, specialized program area content courses, and field experiences with partner schools.

Curriculum Resources: The faculty members further identified the curriculum resources used when implementing Indiana K-8 CS standards. A summary is provided in Figure 4.

Figure 4

Curriculum Resources



Notes. Results of what curriculum resources were used for including the standards (N=18)

The responses included Code.org (n=10), Scratch (n=9), plugged activities (n=9), unplugged activities (n=9), field experiences/practicum (n=7), Hour of Code (n=6), PLTW (n=3), CS First (n=2), specific curriculum (n=3), and other (n=3). The faculty members also provided some examples for plugged activities (n=9), field experiences/practicum, specific curriculum, and other resources. For plugged activities, respondents reported that their Elementary Teacher Education Programs used web resources (e.g., Twine, Ellipsis Education, Nextech), educational technology tools (e.g., micro bits, robots, 3D printing), and coding programs.

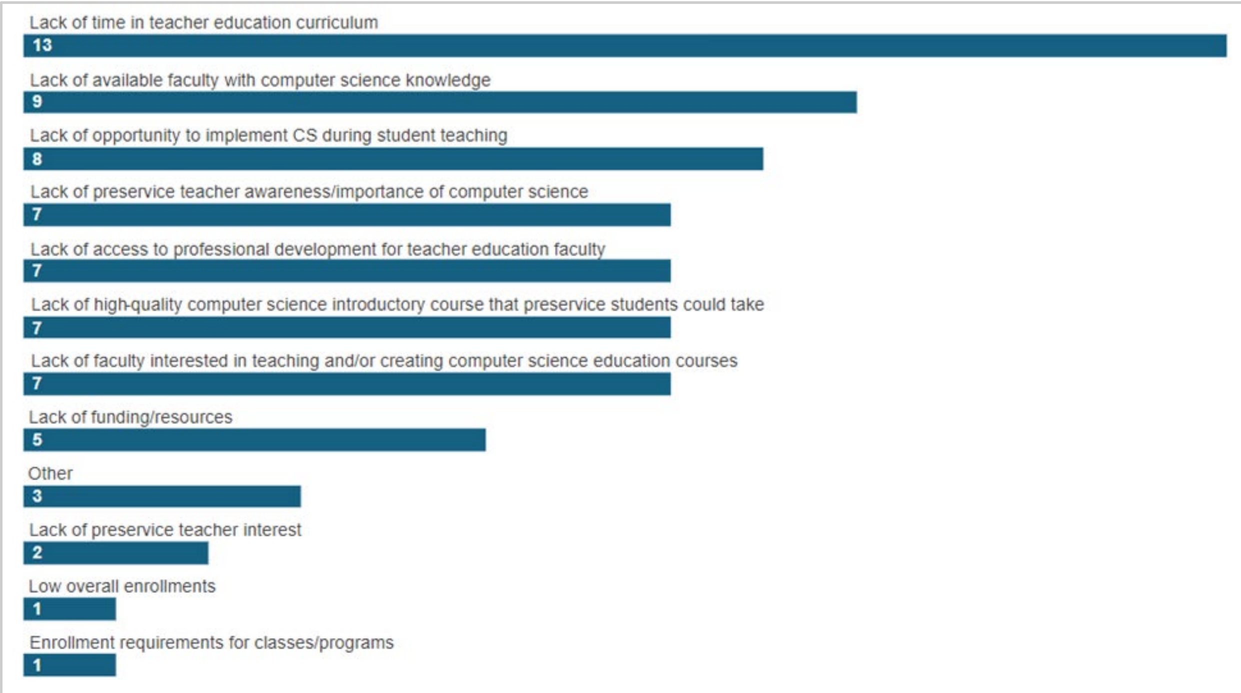
As for field experiences/practicum (n=7), some programs conducted field experiences in STEM schools or STEM nights, while another program's faculty member expressed that the opportunities were different based on schools ("*Our field experiences differ by school*"). One faculty member shared an example of how the field experiences were implemented by utilizing "*Robot and Scratch units with K-6 students; some unplugged activities as warm-ups.*" Additionally, two faculty members stated that their field experiences were expected to include technologies. One of them noted that "*the faculty has not been specific about which CS standard their tech component addresses but plans to ask students to cite the CS standard if using plugged or unplugged activities.*"

For specific curriculum (n=3), one faculty member shared that the program used "*some CS First activities; Code.org; and Scratch cards.*" Another faculty member said they used "*Ellipsis Education and NexTech (Code.org) overview - computational thinking.*" One also mentioned that "*in Math and Science, they (students) practice coding (Code.org) and learn to apply appropriate apps to content for which they are teaching.*" However, this participant also listed several technology integration examples such as using LMS, digital portfolio, or "*create a lesson using DocsTeach.*" Three faculty members expressed that they used other resources. One of them shared: "*We do 5-6 "projects with Makecode such as spoil sensors; pedometers, etc.*" Another one indicated that the "*Basic CS Skills are explained and used in Digital Literacy and Lesson Planning Course as well.*"

Barriers Encountered: The faculty members also shared some of the barriers they encountered when including Indiana K-8 CS standards. Most of them indicated a lack of time in the teacher education curriculum (n=13), lacking available faculty members with CS knowledge (n=9), and lacking opportunities to implement CS in student teaching (n=8). Figure 5 provides a summary of the various barriers indicated by participants.

Figure 5

Barriers



Notes. Results of what barriers were encountered when including the standards (N=18)

Several faculty members also mentioned other barriers that were not listed in our survey item (n=3). For example, one faculty member expressed the program experienced a "*lack of opportunity for preservice teachers to teach CS lessons.*" Another explained that they did not have a stand-alone CS course, so CS was mostly included in the Introduction to Engineering course. Therefore, CS was rarely included in fundamental courses such as math and science courses and student teaching. One faculty member mentioned the barrier they encountered was that most of the current CS resources "*do not intersect with the emphasis on justice, equity, diversity, and inclusion that our program centers, nor do the programs address the urban context.*"

Indiana K-8 CS Standards Not Covered

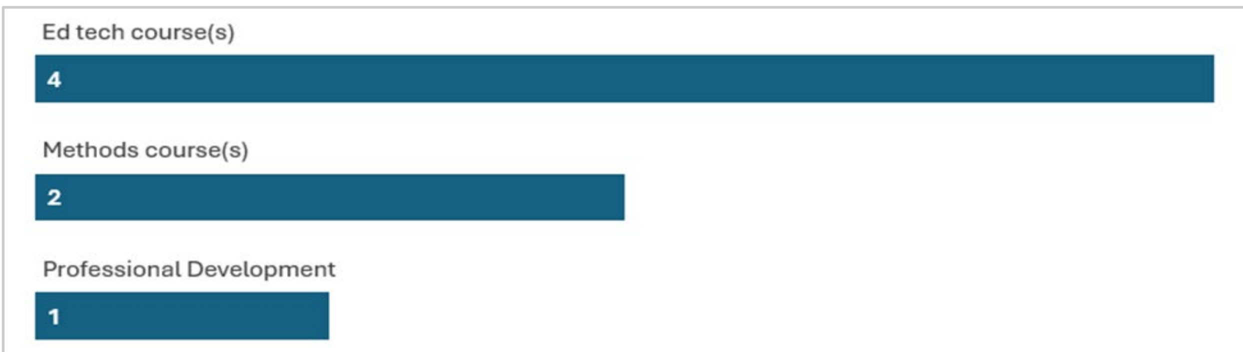
Five faculty members responded that they did not cover Indiana K-8 CS standards in their programs. Among the five faculty members who replied that their programs did not cover

Indiana K-8 CS standards, four of them indicated that they were considering addressing the standards, while one of them replied they were not considering addressing the standards.

Further, the four faculty members expressed that they were most interested in addressing the standards in the Ed-tech course(s) (n=4). Two wanted to address them in method course(s), and one was considering implementing the standards in professional development (Figure 6).

Figure 6

Considerations on How to Address Standards



Notes. Results of how the participants are considering addressing the standards (N=4)

One of the faculty members specifically stated that "*We offer an ed-tech course, but it focuses on using tech to manage, organize, and teach -- not specifically computer science. Our faculty need to learn about CS before they can integrate it in methods courses.*"

For the one faculty member who expressed that the program was not considering addressing the standards, we investigated what kind of barriers the program encountered or impeded them in addressing the standards. The faculty member expressed that there was a lack of faculty interested in teaching CS and creating computer science education courses, a lack of available faculty with computer science knowledge, and a lack of time in teacher education curriculum.

Interview Findings

The findings in this section are presented based on the themes that emerged from the interviews. They are listed and supporting categories are provided in Table 5. Descriptions and interview quotes of each theme are included under the headings in this section.

Table 5
Themes: Interview Findings

Themes	Categories
Strategies Used When Teaching and Integrating CS	● Curriculum & Resources ● Integration
Authentic CS Teaching Experience	● Partnering ● Real-world connection ● Problem-solving
Challenges Faced When Teaching and Integrating CS	● Content & Pedagogy ● Support

Strategies Used When Teaching and Integrating CS

Participating faculty members shared their progress regarding teaching CS. Even though none of the participants' programs had standalone CS courses, they were able to integrate the concepts using available resources. The integration was emphasized as they included CS content and resources into their existing methods and other subject-specific teacher preparation courses. Platforms such as Code.org and Scratch played a key role in providing preservice teachers with examples of how CS is taught in elementary schools' curricula. The examples equipped preservice teachers with interactive and varied content. One of the participating faculty mentioned the benefits of opportunities to explore those platforms and resources. Below is the participants' description of how it helps preservice teachers connect with real-world CS teaching:

> So, we do scratch junior with the second graders. Then we scratch with the fourth and upgraders. ... And once they start, they see how smart these kids are when they start coding. Our students all get excited. ... And so, then they start to appreciate why it's important, you know, but not until you do that. (Casey, lines 207-211).

Authentic CS Teaching Experience

More real-world examples and opportunities benefit teacher preparation programs. This could be achieved by having preservice teachers practice teaching and integrating CS into their early lesson plans and practicum experiences. The following example was shared by another faculty member. They explained how they started integrating CS resources used by elementary students, and how it helped their preservice teachers learn more about the CS in the 5th/6th grade classrooms:

> The dance party in Code.org and actually, the way that got started is, I had another faculty member, and I noted students in fifth grade, and the fifth graders came in and taught the college kids how to use Code.org. And so now we've just implemented that as an assignment every year in science methods. (Azure, Lines 104-107).

In addition, the same faculty expressed their concerns about the quality and the existence of CS teaching experiences that preservice teachers are exposed to during their student teaching practicums. They emphasized the role of the partnering schools and inservice teachers in providing real-world CS teaching opportunities: "How much experience they get in the field is I imagine the cooperating teacher dependent." (Azure, Lines 132-133).

Challenges Faced When Teaching and Integrating CS

The findings highlighted challenges in integrating and incorporating CS into elementary preservice teacher preparation programs. However, important concerns shared by participating faculty members emphasized the limited nature of classroom teaching and field experiences. According to two of the participants, when their preservice teachers visited elementary schools during their practical sessions, they did not always observe CS integration in the classrooms. Faculty members expressed a need for additional examples, particularly from in-service teachers, illustrating how they effectively address computer science standards in their teaching practices. Below is an example of how a faculty member expressed that it was challenging to teach CS to preservice teachers without concrete examples of exemplary curriculums from K-6 classrooms. This highlights a goal for practical and real-world applications that can enhance the understanding, implementation, and integration of CS in elementary education.

> I think something else for me is I haven't seen, and maybe it's just the area I'm in. I'm not sure I haven't seen a solid elementary school that is integrating computer science

> standards themselves. So, it's hard to train somebody to enter something that I'm not sure that I actually seen yet. So, I think it would be helpful to see what it looks like in an elementary school, doing it well, seeing the curriculum, all of those. (Armani, Lines 261-265)

Additionally, participating faculty members highlighted the complex decision between offering their preservice teachers standalone computer science courses and integrating them more broadly into the context of other courses of their entire educational programs. As one of the participants mentioned, this process should involve the other faculty members of the program:

> I think would be a good thing to do is to do a curriculum audit across the program and look at it using different lenses. I think it's necessary for everybody to do … and then but that you know that I think that would provide an opportunity to get the entire program on the table. (Bellamy, Lines 115-123).

This underscores the importance of effective coordination with other courses and the seamless inclusion of computer science within the overall program. Ensuring a cohesive approach to incorporating computer science education is imperative for optimizing the learning experience and preparing preservice teachers to be ready to teach and integrate CS. Participants also emphasized the importance of support for integration and collaboration, underscoring the need for a cohesive approach to incorporating computer science across various courses in their elementary preservice teacher education programs.

Resources Findings

We analyzed the resources using content analysis to corroborate the interview findings. Table 6 shows the resources, content, and their alignments with the interview themes. Most of the resources aligned with the theme of “Strategies Used When Teaching and Integrating CS” as they demonstrated the variety of resources used and integration strategies implemented. In addition, the theme of “Authentic CS Teaching Experience” is situated with the content of resources that involve problem-solving, real-world connection, and teaching experiences.

Table 6

Resources Findings

Type of Resource	Content	Interview Themes Alignment Explained
assignment sheet & instructional material (slide deck)	understanding and using generative AI tools in teaching elementary reading lessons	*Strategies: Curriculum & Resources* Faculty member created their curriculum resources by adding available and openly accessible tools and resources *Strategies: Integration* The functions and the usage of a generative AI were explained and implemented to teach a reading lesson
activity sheet	writing prompts for generative AI; Lexile Reading System	*Strategies: Curriculum & Resources* Faculty member created their curriculum resources by adding available and openly accessible tools and resources *Strategies: Integration* Practicing writing prompts for generative AI and generating Lexile-level texts
syllabus	storytelling, computational thinking, and fundamentals of computer programming	*Strategies: Integration* Alignment of storytelling and CS and CT *Strategies" Integration* Alignment and implementation of IN CS standards throughout the course content
module	storytelling, folk tales, fairy tales, algorithms, CS basics	*Strategies: Curriculum & Resources* Faculty member created their curriculum resources by adding available and openly accessible tools and resources *Strategies: Integration* Alignment of the content and the context/outcomes of the storytelling and the CS/CT concepts *Authentic experience: Real-world connection* Connection with real-world examples and the problems *Authentic experience: Problem-solving* Addressing problems that exist in the real

		world, suggesting creative solutions
syllabus	introduction to STEM, computer programming, engineering design	*Strategies: Integration* Implementation of STEM, problem-solving, design, and CT concepts *Authentic experience: Real-world connection* Connection with real-world examples and the problems *Authentic experience: Real-world connection* Visiting an elementary school for a real-world classroom experience *Authentic experience: Problem-solving* Creating a solution to real-world problems
syllabus	engineering & designing for learning, coding, AI, micro bit make code, programming with Scratch	*Strategies: Curriculum & Resources* Faculty member created their curriculum by adding available tools and resources *Strategies: Integration* Engineering and CS *Authentic experience: Real-world connection* Connection with real-world examples and the problems *Authentic experience: Real-world connection* Visiting an elementary school for a real-world classroom experience *Authentic experience: Problem-solving* Creating a solution to real-world problems based on the community project
activity	unplugged activity, understanding sorting networks	*Strategies: Curriculum & Resources* Faculty member implemented open and available resources *Strategies: Integration* Problem-solving, Math, and algorithms
instructional material	introduction to science	*Strategies: Curriculum & Resources*

(slide deck)	inquiry, learning about robots	Faculty member implemented open and available resources
tentative agendas	STEM night, maker space	*Authentic experience: Real-world connection* Visiting an elementary school for a real-world classroom experience

Conclusion and Recommendations

The findings of the needs analysis suggest that many Indiana Elementary Preservice Teacher Education Programs incorporate CS into their courses. When a dedicated CS course was not available, programs utilized other platforms and resources. Faculty members who reported not addressing Indiana K-8 CS Standards in their programs mentioned they were considering integrating CS into their Ed-tech courses. Participants emphasized the need to balance offering standalone CS courses versus integrating CS into existing courses, with most programs opting for integration into methods courses due to time and curriculum constraints. Effective communication across courses and the comprehensive inclusion of CS in preservice teacher preparation programs is essential, requiring a cohesive approach and support from program leadership. Challenges related to faculty preparation include the lack of faculty with CS knowledge, limited access to professional development, and low faculty interest in CS. This underscores the importance of guiding and supporting faculty members in teaching CS, which will inform future professional development for faculty.

Additionally, it is important to highlight the limited CS teaching practice opportunities, which requires a potential solution of incorporating field experiences that demonstrate effective CS teaching by in-service teachers. This will enhance preservice teachers' understanding of CS integration in elementary education. While programs include CS standards through field experiences, the implementation varies, highlighting the need for well-prepared in-service teachers to model high-quality CS practices. Addressing such a challenge requires a long-term approach, and future efforts should focus on developing instructional resources for CS integration and providing collaboration opportunities for faculty with in-service teachers and elementary schools.

Below are several recommendations based on the results of this needs analysis:

- Integrate CS in methods courses to address CS standards and provide opportunities for preservice teachers to be introduced to teaching CS in elementary grade levels. While several programs use a stand-alone course, the results suggest that an integrated approach to including CS in the elementary curriculum with coordination and collaboration across several courses in the elementary education program may be more effective. This may address the major barrier of "lack of time" that was reported by spreading CS integration across several courses and program activities.
- Create environments for preservice teacher educators and faculty members, to learn CS, and access professional development and other resources can improve the implementation of CS and CS standards into their Elementary Preservice Teacher Preparation Programs. One of the major barriers discussed by participants was lack of content knowledge. Enhancing opportunities to learn CS could address this barrier.
- Collaborate with in-service teachers to facilitate providing preservice teachers with real-world learning opportunities through field experiences and student teaching practicums. This will improve preservice teachers' competencies in implementing CS standards in their future classrooms, while also providing opportunities for in-service teachers to both enhance their own knowledge of CS and facilitate the stronger integration of CS into current curricular activities.

References

Clarke, V., & Braun, V. (2017). Thematic analysis. The journal of positive psychology, 12(3), 297-298.

International Society for Technology Education. Computational Thinking. Retrieved January 14, 2024, from https://iste.org/computational-thinking

K-12 Computer Science Framework. (2016). K-12 Computer Science. Retrieved January 13, 2024, from https://k12cs.org

Mason, S. L., & Rich, P. J. (2019). Preparing elementary school teachers to teach computing, coding, and computational thinking. Contemporary Issues in Technology and Teacher Education, 19(4), 790-824.

Milliken, A., Cody, C., Catete, V., & Barnes, T. (2019, July). Effective computer science teacher professional development: Beauty and joy of computing 2018. In Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education (pp. 271-277).

Ozogul, G., Karlin, M., & Ottenbreit-Leftwich, A. (2018). Preservice teacher computer science preparation: A case study of an undergraduate computer education licensure program. Journal of Technology and Teacher Education, 26(3), 375-409.

Pollock, L., Mouza, C., Czik, A., Little, A., Coffey, D., & Buttram, J. (2017, March). From professional development to the classroom: Findings from CS K-12 teachers. In Proceedings of the 2017 ACM SIGCSE technical symposium on computer science education (pp. 477-482).

Ravitz, J., Stephenson, C., Parker, K., & Blazevski, J. (2017). Early lessons from the evaluation of computer science teacher professional development in Google's CS4HS program. ACM Transactions on Computing Education (TOCE), 17(4), 1-16.

Scanlon, D., & Connolly, C. (2021). Teacher agency and learner agency in teaching and learning a new school subject, Leaving Certificate Computer Science, in Ireland: Considerations for teacher education. Computers & Education, 174, 104291.

Yadav, A., Hambrusch, S., Korb, T., & Gretter, S. (2013). Professional development for CS teachers: A framework and its implementation. Future directions in computing education summit.

Appendix A. Survey Questions

You are receiving this questionnaire because you have been identified as someone with knowledge of your preservice elementary teacher education program.

This questionnaire is intended to review how you incorporate (and/or the challenges you face incorporating) computer science (CS) into your teacher education program. The results will assist us with determining the needs of elementary education faculty in Indiana when it comes to integrating CS standards/content into their curricula. Computer science is different from educational technology (see CSTA CS, ISTE CT & ISTE Technology). If you are unfamiliar with the computer science requirements in your program, please forward this email to individuals who will have more knowledge of how CS is incorporated into preservice teacher education programs at your institution.

The questionnaire is brief (five items) and should not take you more than 10 minutes to complete. If you have any questions or concerns regarding this questionnaire, feel free to contact Dr. Anne Leftwich (aleftwic@iu.edu) or Dr. Tom Brush (tbrush@iu.edu). Thank you in advance for your participation!

Questions:

1. Do you currently cover any of the Indiana K-8 CS standards in your Elementary Teacher Education Program?
    - Yes
    - No
    - Unsure

If "Yes" selected

2. Are the Indiana K-8 CS standards covered in courses/experiences required for your students to complete as part of their teacher education program?
    - Yes
    - No
    - Unsure

3. How are the Indiana CS K-8 standards covered in the Elementary Teacher Education Program? Select all that apply.
    - ❑ Professional development
    - ❑ Ed-tech course(s)
    - ❑ Methods course(s)
    - ❑ Other (please specify) [open]

If "Methods course(s)" selected

a. Which methods course(s)?
[open]

4. Please identify the curriculum resources you use to include the Indiana K-8 CS standards in your Elementary Teacher Education Program. Select all that apply.
   - ❑ Hour of Code
   - ❑ CS First
   - ❑ Scratch
   - ❑ Code.org
   - ❑ PLTW
   - ❑ Unplugged activities (e.g., integrating CS ideas without computers)
   - ❑ Plugged activities (Please specify, e.g., integrating CS ideas with computers) [open]
   - ❑ Field experiences/practicum (Please specify) [open]
   - ❑ Specific Curriculum (Please specify) [open]
   - ❑ Other (Please specify) [open]

5. What are some barriers you have encountered while trying to include the Indiana K-8 CS standards in your Elementary Teacher Education Program? Select all that apply.
   - ❑ Lack of faculty interested in teaching and/or creating computer science education courses
   - ❑ Lack of available faculty with computer science knowledge
   - ❑ Enrollment requirements for classes/programs
   - ❑ Lack of time in teacher education curriculum
   - ❑ Lack of funding/resources
   - ❑ Lack of opportunity to implement CS during student teaching
   - ❑ Lack of high-quality computer science introductory courses that preservice students could take
   - ❑ Lack of access to professional development for teacher education faculty
   - ❑ Lack of preservice teacher interest
   - ❑ Lack of preservice teacher awareness/importance of computer science
   - ❑ Low overall enrollments
   - ❑ Other (Please specify) [open]

6. It would be helpful to learn about your Elementary Teacher Education Program and look at your syllabi and other resources. If you are willing to share your resources, you can attach files below, or feel free to email the resources to tbrudh@iu.edu and aleftwic@indiana.edu.
[file attachment]

7. Would you be willing to participate in a brief interview (either via telephone or Zoom) to discuss your program in more detail? If so, please provide us with the best way to contact you (e.g., email address, phone number).

If "No" selected

2. Are you considering addressing the Indiana K-8 CS standards in any of your Elementary Teacher Education Programs?
   - Yes
   - No

If "Yes" selected

3. Please select what you are considering.
   - ❑ Professional development
   - ❑ Ed-tech course
   - ❑ Methods course (Please specify) [open]
   - ❑ Other (Please specify) [open]

If "No" selected

3. What are some barriers you have encountered that have prevented/impeded you from addressing the Indiana K-8 CS standards? Select all that apply.
   - ❑ Lack of faculty interested in teaching and/or creating computer science education courses
   - ❑ Lack of available faculty with computer science knowledge
   - ❑ Enrollment requirements for classes/programs
   - ❑ Lack of time in teacher education curriculum
   - ❑ Lack of funding/resources
   - ❑ Lack of opportunity to implement CS during student teaching
   - ❑ Lack of high-quality computer science introductory courses that preservice students could take
   - ❑ Lack of access to professional development for teacher education faculty
   - ❑ Lack of preservice teacher interest
   - ❑ Lack of preservice teacher awareness/importance of computer science
   - ❑ Low overall enrollments
   - ❑ Other (Please specify) [open]

4. Would you be willing to participate in a brief interview (either via telephone or Zoom) to discuss your program in more detail? If so, please provide us with the best way to contact you (e.g., email address, phone number).

If "Unsure" selected

2. Could you provide a contact of a person who may be able to address these questions? [open]
3. Would you be willing to participate in a brief interview (either via telephone or Zoom) to discuss your program in more detail? If so, please provide us with the best way to contact you (e.g., email address, phone number).

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix B. Interview Protocol

Interview Note: Agreed-upon definitions of computer science or computational thinking for K-12 students are difficult to come by. For the purposes of this interview, we will use the definition of concepts and practices provided by the K-12 Computer Science Education Framework, and the Operational Definition of Computational Thinking for K-12 from the International Society for Technology Education (ISTE). Computational thinking describes approaches to problem-solving and habits of mind that are associated with computer science, most often in application areas beyond the use of the computer. Computer science describes using the power of computers to solve problems. Computer science, information technology, information systems, and software engineering are all fields under the umbrella term of computing. We have decided to use computer science as the term most commonly understood when we reference students learning about concepts and skills that might fit into any of these fields.

Interview Questions:

1. In your elementary preservice teacher program, do you cover any CT/CS concepts in any of your elementary education coursework?

If YES:

2. Can you describe how you started this program?
3. Is this a requirement?
4. Describe the methods you use to integrate CT/CS into your program.
5. What curriculum do you use?
6. What courses are required? Can you explain a little more about that?
7. Do you have any field experiences associated with learning about CT/CS?
8. Would you be willing to share a copy of a syllabus or materials on how you address computer science or computational thinking in your elementary coursework?
9. What barriers have you encountered while trying to include computer science or computational thinking in your elementary education program?

If NO:

10. If you haven’t integrated CT/CS into your elementary program, do you plan on it? Why or why not?

Thank you for your time!