2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION
Paper ID #50189

Pathways to Licensure for Computer Science Teachers: The Data Landscape (Work in Progress)

Dr. Julie M. Smith

Dr. Julie M. Smith is a senior education researcher at the Institute for Advancing Computing Education. She holds degrees in Software Development, Curriculum & Instruction, and Learning Technologies. Her research focus is computer science education and AI education, particularly the intersection of learning analytics, learning theory, and broadening participation. She was a research assistant at MIT's Teaching Systems Lab; she is also co-editor of the SIGCSE Bulletin.

Jennifer Rosato, University of Minnesota - Twin Cities

Pathways to Licensure for Computer Science Teachers: The Data Landscape (Work in Progress)

Julie M. Smith[1] and Jennifer Rosato[2]

[1]Institute for Advancing Computing Education
[1]julie@csedresearch.org
[2]University of Minnesota - Twin Cities
[2]jrosato@umn.edu

Abstract

Introduction. This work in progress explores pathways to computer science (CS) teacher certification. The U.S. collects data on initial teacher certification, but many CS teachers earn CS licensure by a different pathway, such as by adding CS to a previous license. Thus, there is a gap in data concerning the pathways to CS licensure. This gap may present barriers to improving CS education, given that important insights into recruiting and preparing CS teachers may be unknown due to a lack of knowledge about teachers' pathways. Gaps in our understanding of CS teacher pathways may pose particular challenges to states as they seek to expand high-quality CS learning opportunities for all students.

Methodology and Processes. We are engaged in a two-year project to gather data about the pathways to CS certification – including the number and characteristics of teachers who follow each pathway. This work describes the results from our first year, which involved piloting data collection for ten states via document analysis and interviews with state CS leaders.

Results. We have identified over 80 different pathways to CS certification in total, with requirements ranging from the more common (e.g., passing a CS content exam) to the less common (e.g., a portfolio review). We found that interviews with state CS leaders were essential to gaining knowledge that was not necessarily apparent from the state's licensure website and other online documentation. The second phase of the project will involve the use of data requests to gather information from states about the number of teachers who follow each pathway as well as the characteristics (i.e., race/ethnicity, gender, years of teaching experience, disability status) of these teachers. We are also gathering data about the institutions authorized by each state to prepare teachers for CS certification, as well as the count of sections of CS courses taught by teachers according to the teacher's pathway to CS certification. This data will be used to better understand the landscape of CS teacher pathways.

1 Introduction and Background

Computer science (CS) is a key component of engineering education, not only because CS is a subset of engineering education but also because engineers increasingly use CS skills [1], a trend likely to accelerate as AI (itself a subset of CS) becomes a ubiquitous tool for engineers [2]. Skills central to CS support engineering education skills; for example, computational thinking skills are crucial to engineers and are thus a concern of engineering education research [3–6]. Thus, the state of K-12 CS education – including how CS teachers are prepared – will have an important influence on engineering education and, ultimately, the professional practice of engineering.

The U.S. government gathers data on initial teacher certification, but many CS teachers gain CS certification via another route. For example, one pathway to CS certification is as an add-on endorsement to another certification. As a result, there are gaps in our knowledge of the pathways to CS certification. These gaps may present barriers to improving CS education, given that important insights into recruiting, training, and assessing CS teachers may be unknown. While paths to CS certification are similar to paths in other content areas, some states do offer different paths (e.g., a CS "micro-endorsement" in Georgia that permits teaching introductory CS courses while pursuing full certification). These paths may ease shortages of CS teachers [7]. Similarly, for most states, the levels permitted to teach (e.g., middle school) parallel what is permitted by other certifications, and there are mechanisms for permitting teachers without a CS certification to teach in exigent circumstances.

The lack of knowledge about pathways means that it is difficult to research the implications of those pathways and their requirements [8]. Eleven states have created CS graduation requirements for all students in the last decade [9], and gaps in our understanding of CS teacher pathways may pose particular challenges to these states as they seek to scale high-quality CS learning opportunities for all students.

In an effort to remedy this lacuna in data about CS teacher pathways, we are engaged in a two-year project to gather data – including the characteristics of CS teacher pathways as well as the number and characteristics of teachers who follow each pathway. This work describes the results from our first year, which involved piloting data collection for ten states via document analysis, interviews with state CS leaders, and requests for data.

2 Methodology

This project involved the analysis of CS teacher preparation pathways in ten states (Alabama, Arkansas, Georgia, Hawai'i, Indiana, Maryland, Minnesota, Pennsylvania, Texas, and Washington). These states were chosen because they represent a variety of approaches to CS teacher preparation (e.g., requirements differ between states, some have more than one CS license while others have none).

We used two data sources for this project. First, we conducted a content analysis of publicly accessible state documents that describe requirements for the state's certification pathways. These documents included general overviews of requirements, forms for teacher candidates to complete, and so forth. Second, we conducted interviews with representatives of each state with expertise in their state's CS teacher preparation programs and data collection efforts. We used the interviews to verify and contextualize the information gathered from the content analysis.

We categorized each certification pathway as belonging to one of the following categories: (1) initial certification via an institution of higher education, (2) initial certification via an alternative provider, (3) add-on to an existing teaching license, (4) authorization based on another teaching license, (5) out-of-state teachers, and (6) other. We also noted the requirements (e.g., coursework, a standardized test) for each pathway. Some pathways allow the candidate several options; in these instances, we collapsed the options into a broader descriptive category. For example, if a candidate had the option to be (1) licensed in another state, (2) have a National Board certificate, or (3) present a portfolio of their work, we categorized this group as requirements related to pedagogical knowledge.

3 Results

3.1 Findings Related to the Data-Gathering Process

We identified two major challenges to the process of gathering and cleaning the data sought for this project. First, an understanding of the local context is crucial. For example, in Texas, school districts may be designed a District of Innovation if they meet certain performance metrics; this designation exempts them from some requirements, including those related to teacher certification [10]. Similarly, content analysis of documents from Indiana identified a very limited selection of CS classes; local expertise was needed to identify additional CS courses that were cataloged separately as career and technical education (CTE) courses. Thus, we found that input from state CS education experts is an important means to contextualize the data gathered from the content analysis of documents related to CS teacher pathways.

A second challenge was capturing an appropriate level of nuance in the data without sacrificing the ability to aggregate data. For example, many pathways require prospective CS teachers to pass a CS exam. But the passing score differs by state, some states have passing scores that differ by the prospective teacher's GPA, and states differ in which test is required (e.g., Praxis, GACE, WEST/NES). As a result, there are differences in pathways even when they have the same requirement. As another example, we limited each pathway requirements list to *explicit* requirements (i.e., requirements specifically mentioned in the state's documents). But in most states, holding a college degree is *not* an explicit requirement for candidates who hold a certificate in another state (while the vast majority of these teachers likely have a college degree, there are some pathways – usually CTE-related – that do not require a college degree [11]). Therefore, the data suggests that only half (49.4%) of pathways require a college degree, but this finding is in many ways misleading since, implicitly and in practice, virtually all pathways require a college degree. Another challenge to data organization and analysis was determining how to capture one requirement that had multiple options for meeting it, such as Hawai'i's CS license that allows for coursework, an exam, or an industry certification to be used to meet its requirement to show CS content knowledge.

3.2 Findings Related to the Data Itself

Broad Patterns

Not every state has a certification pathway in each of the categories. For example, Arkansas does not have an option to earn an initial CS license via an institution of higher education, although one could earn an initial CS license via an alternative provider, such as Teach for America. Because Minnesota does not currently have a CS license, it has few pathways: authorization (e.g., teachers with a math license are authorized to teach some CS classes; teachers with visual or performing arts licenses are authorized to teach other CS classes) and "other" (since a teacher without authorization may teach a CS course with permission to teach out-of-field).

The least commonly-offered category of pathways across states is authorization, with only 40% of states (Arkansas, Maryland, Minnesota, and Texas) in our sample offering this option. The most commonly offered categories were adding on CS to an existing license and initial certification via an alternative provider; both of these categories of certification pathways were offered by every state in our sample save Minnesota (since it does not offer a CS license).

Requirement Frequency

Table 1 shows the percent of pathways with each requirement, by type of pathway.

As described above, because we only cataloged explicit program requirements, some requirements for licensure may be undercounted. Nonetheless, comparing the frequency of the various requirements may be useful for gaining insight into the nature of CS license requirements. Some requirements are quite rare. For example, only one pathway (Arkansas' Professional Educator Pathway, an alternative initial licensure pathway) requires a year-end evaluation. Similarly, while some programs allow portfolios as one of several possible options to meet a pathway requirement, no pathway in our dataset requires portfolios of work.

4 Discussion

As mentioned in the Results section, we found that a content analysis alone would have left substantial gaps or misunderstandings in the descriptions of teacher pathways due to lack of knowledge about the local context. Thus, despite the time and effort required, discussing and vetting our findings with state CS education experts is justifiable due to the important insight provided. More challenging were instances related to the process of capturing the appropriate amount of nuance without limiting the ability to aggregate data. For example, we chose to exclude implicit requirements (e.g., a college degree) due to the subjectivity and propensity for error of including them. At the same time, we considered the potential for misleading findings (e.g., that a bachelors degree is only required by about half of pathways) when describing and interpreting our findings. In short, balancing nuance and aggregation is a tension to be managed, not a problem that can be entirely solved.

Based on the states in our dataset, we can make several observations about requirements. First, requirements tend not to be universal unless they are an inherent requirement of a given pathway category; for example, all add-on pathways require a license in another subject, but very few other pathways have this requirement. Similarly, all IHE initial (that is, initial certification via an institution of higher education) pathways require a bachelors degree, which is otherwise not commonly an (explicit) requirement. The most common requirements overall (e.g., a CS exam, a bachelors degree) tend to be objective in nature and to focus on content knowledge. Less common requirements (e.g., review of credentials, year-end evaluation) are sometimes less objective, less likely to scale for assessors, and less clearly focused on content knowledge.

There are two main limitations of this study. First, as this is a pilot project, we have only gathered data from 10 states. We expect future data collection efforts to provide a clearer picture of the pathways to CS certification in the U.S. Second, data aggregation often required subjective decision-making; for example, see the methodology section for a discussion of how requirements with multiple options for the candidate were coded.

Table 1: Percent Occurrence of Pathway Requirements by Pathway Category

Requirement	Add-On	Out-of-State	IHE Initial	Other Initial	Authorization	Other	All
CS exam	50%	40%	90%	59%	17%	-	47%
bachelors degree	19%	20%	100%	62%	-	62%	49%
licensed in another subject	100%	-	-	-	67%	8%	24%
review of credentials	-	20%	-	-	-	-	2%
licensed in another state	-	90%	-	-	-	-	10%
student teaching	-	-	60%	3%	-	-	8%
coursework	12%	-	50%	47%	17%	23%	30%
mentored teaching experience	-	-	10%	47%	-	15%	21%
employee of a district of innovation	-	-	-	-	33%	-	2%
teaching experience	-	20%	-	12%	-	8%	8%
industry experience	-	-	10%	25%	-	31%	15%
content knowledge	19%	-	-	19%	-	15%	13%
pedagogical knowledge	12%	20%	-	9%	-	8%	9%
National Board certificate	-	-	-	-	-	8%	1%
occupational competency assessment	12%	-	-	-	-	-	2%
professional development	12%	10%	-	28%	-	-	14%
high school graduation	-	-	-	6%	-	8%	3%
industry certification	-	-	-	-	-	8%	1%
working toward certification	-	-	-	3%	-	23%	5%
masters degree	-	-	-	9%	-	-	3%
PRAXIS PLT exam	-	-	-	6%	-	-	2%
teaching position	-	-	-	31%	-	-	11%
citizen of another country	-	-	-	-	-	8%	1%
year-end evaluation	-	-	-	3%	-	-	1%
PRAXIS Core Academic Skills exam	-	-	-	3%	-	-	1%
associates degree	-	-	-	6%	-	-	2%

5 Conclusions

In the second year of the project, we will finish gathering and analyzing the data from the ten pilot states. We will then refine our approach to gathering data and expand our work to additional states. We hope to launch a sustainable system for gathering, analyzing, and sharing CS teacher pathway data such that we can build a picture of how these pathways – and the teachers who follow them – change over time. We expect our findings to be useful to groups ranging from CS education researchers to CS curriculum developers to teacher educators to those who advocate for or set state-level policies related to teacher certification.

6 Acknowledgments

AI was used to support creating code to generate data visualizations.

We acknowledge Google.org for their generous support of this project.

References

[1] Osman Yasar and Rubin H. Landau. Elements of Computational Science and Engineering Education. *SIAM Review*, 45(4):787–805, January 2003. ISSN 0036-1445. doi: 10.1137/S0036144502408075. URL `https://epubs.siam.org/doi/10.1137/S0036144502408075`.

[2] Mohamed Khaleel, Abdussalam Ali Ahmed, and Abdulgader Alsharif. Artificial Intelligence in Engineering | Brilliance: Research of Artificial Intelligence. September 2023. URL `https://jurnal.itscience.org/index.php/brilliance/article/view/2170`.

[3] Sebastian Gross, Mischa Kim, Joachim Schlosser, Coorous Mohtadi, Dan Lluch, and Dorian Schneider. Fostering computational thinking in engineering education: Challenges, examples, and best practices. In *2014 IEEE Global Engineering Education Conference (EDUCON)*, pages 450–459, April 2014. doi: 10.1109/EDUCON.2014.6826132. URL `https://ieeexplore.ieee.org/document/6826132`. ISSN: 2165-9567.

[4] Hendra Hidayat, Zulhendra Zulhendra, Efrizon Efrizon, Vera Irma Delianti, Fitrika Kumala Dewi, Mohd Rizal Mohd Isa, Dani Harmanto, and Jem Cloyd M. Tanucan. Computational Thinking Skills in Engineering Education: Enhancing Academic Achievement Through Innovations, Challenges, and Opportunities. *TEM Journal*, pages 3454–3467, November 2024. ISSN 2217-8333, 2217-8309. doi: 10.18421/TEM134-78. URL `https://www.temjournal.com/content/134/TEMJournalNovember2024_3454_3467.html`.

[5] Alejandra J. Magana and Genisson Silva Coutinho. Modeling and simulation practices for a computational thinking-enabled engineering workforce. *Computer Applications in Engineering Education*, 25(1):62–78, 2017. ISSN 1099-0542. doi: 10.1002/cae.21779. URL `https://onlinelibrary.wiley.com/doi/abs/10.1002/cae.21779`. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/cae.21779.

[6] Noemi V. Mendoza Diaz, Russ Meier, Deborah A. Trytten, and So Yoon Yoon. Computational Thinking Growth During a First-Year Engineering Course. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–7, October 2020. doi: 10.1109/FIE44824.2020.9274250. URL `https://ieeexplore.ieee.org/document/9274250`. ISSN: 2377-634X.

[7] Sujeeth Goud Ramagoni and Dennis Brylow. Addressing the Computer Science Teacher Shortage: A Case Study of Wisconsin Public High Schools. In *Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 1*, SIGCSETS 2025, pages 945–951, New York, NY, USA, February 2025. Association

for Computing Machinery. ISBN 979-8-4007-0531-1. doi: 10.1145/3641554.3701952. URL https://dl.acm.org/doi/10.1145/3641554.3701952.

[8] Anne Ottenbreit-Leftwich, Joshua Childs, Sarah Dunton, and Carol Fletcher. Expanding Equity in Computer Education Policies, Pathways, and Practices Policy Brief: Computer Science Teacher Qualification Pathways and Equity, 2022. URL https://ecepalliance.org/.

[9] Code.org, CSTA, and ECEP Alliance. 2024 State of Computer Science Education. Technical report, 2024. URL https://advocacy.code.org/stateofcs.

[10] Texas Education Agency. Districts of Innovation, December 2025. URL https://tea.texas.gov/texas-schools/district-initiatives/districts-of-innovation. Publisher: Texas Education Agency.

[11] David Blazar, Danett Song, Ramon Goings, Jay Plasman, and Michael Gottfried. Pathways into the CTE Teaching Profession: A Descriptive Analysis of Degrees, Licenses, and Race in Maryland. *AERA Open*, 11: 23328584251361382, December 2025. ISSN 2332-8584. doi: 10.1177/23328584251361382. URL https://doi.org/10.1177/23328584251361382. Publisher: SAGE Publications Inc.