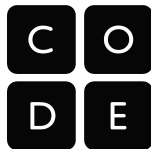# Recommendations for States Developing Computer Science Teacher Pathways

The growth and sustainability of K-12 computer science depends on having an adequate number of well-prepared computer science teachers. However, computer science teachers in many states have no logical pathway to build the necessary skills (including computational thinking) and obtain credentials acknowledging these skills. Few institutions of higher education have preservice teacher preparation programs in computer science, and in 2015, only 51 college graduates across the country received an initial teaching certification in computer science (2015 Title II Reports). Teacher preparedness and credentials are major barriers to offering computer science courses at the secondary level. Every state has clear pathways for mathematics and science teachers, but only 29 states have similar policies for preparing computer science teachers. And even among those states that have computer science teacher certification, there are vast differences among the types of certification they offer, and some of the certifications are not practical for teachers to obtain. The lack of clear and consistent preparation and certification creates confusion among teachers, school districts, and state education authorities, and ultimately undermines the growth and sustainability of the field.

To meet the demand for well-prepared computer science teachers, states should develop multi-pronged approaches to computer science teacher preparation and licensure. Recognizing that states have widely varying rules and regulations on how they approach teacher certification, there are multiple strategies that a state can take to address this problem. States should create pathways to teacher certification that align with their existing preservice teacher preparation, certification, and endorsement pathways. Further, pathways should not overlook the preparation of elementary teachers and generalists in gaining a liberal arts fluency in computer science.

Definitions used in this document

Certification	A full certification or licensure pathway for new or existing teachers to become certified solely as computer science teachers.
Endorsement	A supplemental or extension pathway for teachers who already possess certification in another area (such as mathematics or science).
Computer science	An academic discipline that encompasses the study of computers and algorithmic processes, including their principles, their hardware and software designs, their applications, and their impact on society. (CSTA, 2013)

We recommend that states adopt a system of computer science teacher preparation and certification that includes steps toward short-term goals while working toward long-term goals.

The following table includes suggestions for immediate, short, and long term actions for state-level policymakers to create secondary computer science teacher endorsement and certification.

	Recommendations for secondary computer science teacher endorsement and certification
Immediately	**Allow teachers to teach computer science under a <u>temporary license</u> after receiving state-approved high-quality professional learning.** *Who is this for?* Teachers who are currently teaching computer science courses, or who are needed to begin teaching these courses in the next school year, and have completed some professional learning in teaching computer science. *Why is this important?* Temporary licenses allow a state to scale the computer science teaching force quickly while providing time for the state to finalize plans for an endorsement or certification. These licenses would also be appropriate for teachers who are currently teaching computer science courses out of their licensure area because their state did not offer a clear certification pathway. *What does this include?* Teachers could apply for this temporary license after completing a minimum set of requirements (such as high-quality professional learning in computer science education as determined by the state or by state-approved professional learning providers), and while working towards completion of more in-depth computer science methods and content requirements (content requirements could be based on the concepts and practices identified in the [K–12 Computer Science Framework](#)). Teachers could be required to meet the requirements for a full computer science endorsement within a set time period (such as two years). Content requirements may be met by attending workshops, taking computer science courses, or passing a computer science certification assessment. States could create "scaled" grandfathering systems to recognize the expertise of teachers by allowing veteran computer science teachers with at least one year experience teaching rigorous computer science course(s) to earn an endorsement. If the state chooses, the teacher could be required to show documentation that they have received extensive professional development in

	recent years. States could also explore the use of micro-credentials to allow teachers to teach specific computer science courses after successful completion of professional learning or submission of a portfolio. States could then create a plan for reviewing teachers' documentation on either a rolling basis or at designated times during the year. States may also want to consider planning to reassess the need for the temporary license after a few years. It may be possible to phase this out as add-on endorsements, full certifications, and preservice preparation pathways are developed.
Short term	**Create a secondary <u>add-on endorsement</u> for teachers to earn after completing content and methods requirements.** *Who is this for?* Teachers who have already earned (or are in the process of earning) full certification in another content area. *Why is this important?* States may want to grow the ranks of well-prepared computer science teachers quickly. In particular, until preservice teacher preparation programs have developed full certification pathways for teachers, and for some time while such programs are becoming well-established, it is important that an add-on endorsement is an option for teachers. The endorsement pathways would allow practicing teachers certified in other areas to begin teaching sections of computer science, and it would allow preservice teachers to obtain dual certification in computer science and another content area. It's important that this endorsement be accessible to teachers who are certified in either Career and Technical Education (CTE) or non-CTE academic programs. Endorsement pathways would be useful for states where computer science can satisfy a math or science requirement, to encourage math and science teachers to obtain the endorsement. *What does this include?* The endorsement should include both computer science methods and content requirements. The content requirement could be met by taking at least 12 credit hours of computer science coursework or passing a state-approved computer science certification assessment. Varying levels of endorsement may be appropriate; such as one endorsement for middle school or introductory high school courses, and another for advanced high school courses.

	In the short term, as courses are being developed, the methods and/or content requirements could be substituted with at least 40 hours of high-quality (as determined by the state or by state-approved professional learning providers) computer science professional development. In the long term, candidates would be expected to take coursework from an accredited teacher preparation or college/university program to meet these requirements.

Long term	**Create a secondary <u>full certification pathway</u> for teachers to earn after completing requirements similar to other pathways in the state.**
	
	Who is this for? Preservice teachers or career changers
	
	Why is this important? A full certification pathway is important for creating a sustainable computer science teaching force. Eventually, teacher preparation programs would create preservice programs for computer science teachers, similar to existing ones for mathematics and science teachers.
	
	What does it include? Full certification pathways for computer science teacher certification would include requirements already in place in the state for other initial full certifications, including general education pedagogy, student teaching, methods, and content. The specific requirements would depend on the state and should align with existing full certification pathways in other content areas, but some examples may include:
	    a) For general education coursework, the candidate would complete coursework pursuant to general teacher certification (e.g., may include curriculum design and development, educational psychology, and technology in the classroom), and a passing score on a state-approved assessment on teaching and learning.
	
	    b) For computer science education pedagogy, the candidate would complete a methods course in computer science, and class observations and practice teaching (pursuant to existing teacher certification requirements in the state).
	
	    c) For computer science content, the candidate would complete computer science coursework at the level of receiving a minor, bachelor's degree, or higher in computer science, and passing a state-approved computer science certification assessment as appropriate.

Recommendations for States Developing Computer Science Teacher Pathways, Code.org, 2017

The creation of one or multiple pathways for teachers to become certified in computer science must be complemented by the development and state approval of **preservice** teacher preparation programs in computer science. The following recommendations include immediate, short, and long term suggestions for developing preservice teacher preparation pathways for PreK-12.

	Recommendations for preservice teacher preparation pathways (PreK-12)
Immediately	**Update existing preservice educational technology courses and/or standards for teacher preparation to include modern computer science content.** *Who is this for?* All preservice teachers seeking licensure in any content area, including technology/computer teachers or specialists at the elementary, secondary, or PreK-12 levels. *Why is this important?* For all elementary and secondary teachers, computational thinking should be a necessary part of their preparation. Computer science is included in the definition of a "well-rounded education" under the Every Student Succeeds Act, computational thinking is included in the Next Generation Science Standards, and modeling is included in the Common Core Standards for Mathematical Practice. As such, elementary teachers will be expected to include computer science content and practices in the elementary curricula, integrated into the teaching of other content areas. Further, a basic understanding of computer science, computational thinking, and modeling is essential for all teachers to integrate modern uses of technology into their classrooms. Every STEM teacher in particular should be able to teach the basics of computer science at their grade levels. Including an introduction to computer science in a required education technology course can also serve as a recruiting tool to encourage preservice teachers to seek an add-on endorsement in computer science education. Many states already have a certification or licensure pathway for computer literacy, computer technology, or computer applications for elementary, middle, or PreK-12. The content required for these certifications, while including computer *use*, often do not include computer *science*. These certifications should be modernized by incorporating computer science content into their coursework

and preparation. This can be accomplished in a few different ways; for example, the current certificate could be updated to become a computer science certificate, or the current certificate could be kept but include a computer science strand.

What does this include? 80% of teacher preparation institutions require preservice teachers in at least one program take a course in educational technology, and 60% require the course of all preservice teachers (Gronseth et al., 2010). These courses and the technology fluency standards they address should be updated to include core computational thinking concepts and other basics of modern computer science, including connections to mathematics, science, and other content areas. Discipline-specific computational thinking concepts and pedagogy should be included in these courses by connecting it to content preservice teachers will cover in their future classrooms. Further, every elementary teacher should be able to teach the basics of computer science in their classrooms given appropriate professional development or training in their preparation program. All teacher preparation institutions teach integrating technology into instruction (Educational Technology in Teacher Education Programs for Initial Licensure, 2007); this content should include integrating computer science into instruction.

Computer science should be a major strand in the certification requirements for all technology and computer teachers. Technology education courses and certification competencies should be updated to include modern computer science content. STEM (science, technology, engineering, and mathematics) endorsements should also incorporate computer science. Note that the Council for Accreditation of Educator Preparation has a set of accreditation standards for computer science teacher preparation programs; and the K-12 Computer Science Framework provides details on concepts and practices for all students to learn.

Short term	**Create or adopt an assessment for teacher certification in computer science.** ***Who is this for?*** Any preservice teacher seeking licensure in computer science, or seeking an add-on endorsement in computer science. ***Why is this important?*** The creation/adoption and approval of an assessment for teacher certification in computer science (such as an examination, portfolio, or other assessment) is important for both the

	creation of a certification pathway and to stimulate the development of preservice teacher preparation programs. The content of the assessment can inform the course content in new teacher preparation programs in computer science. *What does this include?* The assessment should include both computer science content and computer science pedagogy. It should be developed or vetted by a diverse team of stakeholders in computer science education in the state, including higher education, industry, and K-12 teacher representatives. The assessment should also be developed as part of a certification or endorsement pathway in the state, and a passing score (on its own or combined with other requirements) should indicate that a teacher is prepared to teach computer science. In 2016, assessment organizations, such as ETS and Pearson, began development of multi-state computer science certification exams.
Long term	**Create and approve full preservice pathways for computer science educators.** *Who is this for?* Any preservice teacher seeking licensure in computer science education. *Why is this important?* In 2015, only 11 preservice teachers in the United States graduated with a major in Teacher Education - Computer Science (2015 Title II Reports). In order to continue to grow the ranks of well-prepared computer science teachers, it is important for teacher preparation programs, including institutions of higher education, to develop full pathways for preservice teachers to become computer science teachers. *What does this include?* The state should set guidelines for preservice teacher preparation programs in computer science and work with institutions of higher education to develop programs to prepare teachers to become certified as computer science teachers. Program approval for computer science teacher preparation programs involves the collaboration of higher education and state education agencies, as well as the alignment of certification requirements, certification assessments, and standards for teachers. Such pathways should include both content and methods in computer science. They may also include interdisciplinary elements on incorporating computer science into other content areas. The programs could enable preservice teachers already earning a certification in one content area to add a second certification area in computer science, or the programs could enable a preservice teacher to obtain a full primary certification in computer science. It may be worth considering whether

	there is enough demand in the state for a teacher to be certified in only computer science, and whether it makes sense for full computer science education pathways to include dual certification in another STEM field. Existing programs in computer science education make it easy and attractive for preservice teachers to add a second licensure area in computer science, such as adding a series of 4-5 additional courses in computer science, a fifth-year master's degree in computer science education, or attaching a program to mathematics education degree. Programs could also entice enrollment with incentives like more field experience, tuition waivers, the potential to become certified in multiple areas, or access to graduate-level courses.

FAQ

Q: Why don't we recommend a K-12 computer science endorsement?
A: The content knowledge and pedagogical content knowledge for teaching computer science is very different at the elementary and secondary education levels. Therefore, we do not recommend that a K-12 (or PreK-12) endorsement or certification is appropriate for computer science. Instead, states should create a full-fledged secondary computer science endorsement and/or certification, and incorporate other strategies, including access to high-quality professional development, for ensuring computer science is taught in every elementary school.

Q: Why don't we recommend an elementary computer science endorsement?
A: All elementary teachers should be able to teach computer science in their classes without needing to acquire an additional endorsement. Instead, we recommend that elementary teachers be able to select computer science as a specialization when earning their degree, that existing technology specialist and STEM endorsements include computer science content, and that *all* elementary teachers be taught computer science methods and integration during existing programs and coursework. Basic *computer science* knowledge, as taught in updated educational technology courses, could replace basic *computer* knowledge in certification requirements for all elementary teachers. Existing elementary teachers could obtain computer science content knowledge via a one-day intensive professional development experience.

Q: What are some related policies that can reduce barriers for teachers who want to become certified to teach computer science?

A: At this point, when certification is difficult to obtain or computer science certification doesn't exist, many teachers are teaching computer science under a temporary or out-of-subject area license. Creating new certifications will result (in the short term) in increased barriers to growing the teacher force. Some ways to mitigate such barriers include: tuition reimbursement for teachers taking computer science or computer science methods courses, salary increases for teachers obtaining an add-on endorsement in computer science, scholarships for preservice teachers to become dual certified in computer science and another content area, and allowing for alternative methods of computer science content and methods mastery (such as micro-credentials or participation in high-quality professional development).

Q: How can computer science professionals become teachers?
A: Most states have existing expedited CTE certification pathways for professionals in industry who wish to become teachers. States should encourage computer science professionals to use these pathways by making sure that the pathways recognize the advanced computing knowledge of computer science professionals while providing appropriate training and experiences with education. Requirements should be similar to other alternative certifications developed by the state, but may include the following: the individual has at least 2 years of experience in related computer science work; holds a bachelor's degree or higher in computer science or a related field with advanced computer science coursework; and completes general education coursework, computer science methods coursework, practice teaching, and passes a state-adopted general pedagogy assessment.

Q: What are some considerations as my state embarks on the process of establishing computer science teacher pathways?
A: State planning should focus on long term goals with a series of steps along the way. Early on, it is important to get all stakeholders together and on the same page. Although early implementation may be related to certification only, schools of education and other preservice teacher preparation programs should be involved from the early stages, because they will primarily be responsible for the programs that teachers use to get certified.

Recommendations for States Developing Computer Science Teacher Pathways, Code.org, 2017

Examples of existing innovative state licensure systems for computer science

Arkansas:
- Computer science is taught in both CTE and academic tracks at the high school level. The state has a new computer science endorsement that can be obtained by teachers with primary certifications in academic subjects or CTE. Further, any teacher with a grade-appropriate license can obtain a computer science approval code to teach computer science by providing documentation of a) teaching computer science courses during 4 of the past 7 years, b) a minor in computer science, c) an approved computer science certification, d) a combination of an approved industry-recognized certification plus college courses in computer science, or e) a combination of years teaching advanced computer science courses and completion of an International Baccalaureate or College Board approved professional development program in an Advanced Placement (AP) Computer Science course. The computer science approval code is a temporary measure that helps schools meet short-term computer science course needs while providing teachers with multiple options for demonstrating their competency in teaching computer science, as well as collecting data on a disparate computer science teaching population in order to help them meet traditional certification requirements later.
- The state also recently approved a preservice teacher preparation program in computer science at an institution of higher education and provides incentives for teachers to obtain certification in computer science. The state will reimburse assessment fees for the first 200 teachers who pass the computer science certification exam, and will pay course fees for the first 50 completers of a non-traditional route to obtaining a computer science licensure.

Utah:
- The state has three levels of computer science teacher certifications which allow the teacher to teach more advanced courses after obtaining a more advanced licensure. The first licensure, called "Exploring CS," requires the teacher to have completed a 20 hour online professional learning program; attend an Exploring CS workshop, ongoing professional learning, the IT Summer and Winter Conference; and successfully pass an industry exam. The second level of licensure, "Computer Science - Level 1," requires the teacher to have a computer science major, minor, or 9 credit hours of specified coursework; a computer science methods courses or an Ed Tech endorsement; attend the IT Summer or Winter Conference; and successfully pass an industry exam. The third licensure, "Computer Science - Level 2," requires teachers to have a computer science major, minor, or 15 credit hours of specified coursework; a computer science methods courses or a combination of a workshop to teach Exploring CS or Computer Science Principles plus attending two IT Summer or Winter Conferences; and successfully pass an industry exam. This three-tiered model of certification allows the state to quickly scale up

introductory computer science exams while simultaneously providing a pathway for teachers who choose to increase their computer science knowledge and teach more advanced courses.

● Teachers can begin teaching computer science after partial completion of the requirements with the submission of a plan to complete the rest of the requirements within a given timeframe.

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