washington
STATE LEARNING STANDARDS

kindergarten – 12th grade

Computer Science

Adopted in 2016

SUPERINTENDENT OF PUBLIC INSTRUCTION

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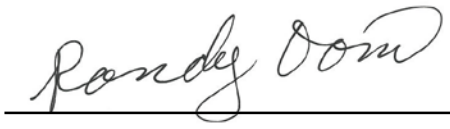
Computer Science K–12 Learning Standards
Adoption Statement

The ***2016 Computer Science K–12 Learning Standards*** were developed collaboratively with teachers, administrators, subject matter experts, state and national associations, and stakeholders in computer science. Teams of Washington teachers, technology integration specialists, and librarians reviewed national standards to determine needs for Washington students.

Since the first draft was made available in December 2015, the Computer Science K–12 Learning Standards have been reviewed by Washington educators, administrators, and family members. The standards underwent a Bias and Sensitivity Review and a Public Comment Period, providing those with a stake in computer science education an opportunity to inform the development and implementation of the standards and supporting documents.

Pursuant to Substitute House Bill (SHB) 1813 and based on support from educators, OSPI's Curriculum Advisory and Review Committee, and statewide computer science stakeholders, I hereby adopt the ***Computer Science K–12 Learning Standards***.

Adopted on this 8th day of December, 2016.



Randy I. Dorn
State Superintendent
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Computer Science K–12 Learning Standards

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Table of Contents

Computer Science Is an Essential Academic Subject

The mission of the Office of Superintendent of Public Instruction (OSPI) is to "provide funding, resources, tools, data and technical assistance that enable educators to ensure students succeed in our public schools, are prepared to access post-secondary training and education, and are equipped to thrive in their careers and lives." Our vision is that "every student is ready for college, career, and life." Effective and relevant computer science education is essential to achieving these aims. While attention to computer science education has increased in recent years, a lack of awareness about its content and potential impact is widespread. The new Washington State Computer Science K–12 Learning Standards are designed to enhance teacher understanding and improve student learning so that students are better equipped for college, career, and life.

Washington is committed to implementing high-quality computer science instruction to:

- Increase the opportunity for all students to gain knowledge of computer science.
- Introduce the fundamental concepts and applications of computer science to all students, beginning at the elementary school level.
- Make computer science at the secondary level accessible, worthy of a computer science credit, and/or equivalent to math and science courses as a required graduation credit (see Level 3B of computer science standards).
- Offer additional secondary-level computer science instruction that allows interested students to study facets of computer science in depth and prepare them for entry into a career or college.

Washington State Learning Goals, Standards, and Outcomes

Learning standards are for all of us: students, principals, administrators, decision-makers, community partners, teachers, and families. They help define what is important for students to know and be able to do as they progress through school. Standards help ensure that students acquire the skills and knowledge they need to achieve personal and academic success. Standards also provide an avenue for promoting consistency in what is taught to students across our state—from district to district, school to school, and classroom to classroom.

These **four learning goals** are the foundation of all academic learning standards in Washington:

1. **Read** with comprehension, **write** effectively, and **communicate** successfully in a variety of ways and settings and with a variety of audiences.
2. **Know and apply the core concepts and principles** of mathematics; social, physical, and life sciences; civics and history, including different cultures and participation in representative government; geography; arts; *and health and fitness* [now named physical education].
3. **Think** analytically, logically, and creatively, and to integrate technology literacy and fluency as well as different experiences and knowledge to form reasoned judgments and solve problems.
4. **Understand** the importance of work and finance and how performance, effort, and decisions directly affect **future career and educational opportunities**.

The **Washington State K–12 Learning Standards** are the required elements of instruction and are worded broadly enough to allow for local decision-making. Depending on school resources and community norms, instructional activities may vary. The 2016 Computer Science K–12 Learning Standards reflect OSPI's continuous commitment to supporting rigorous, inclusive, age-appropriate, accurate instruction to ensure that students are prepared to live productive and successful lives in a global society.

The computer science standards provide guidance to teach, reinforce, and apply the state's learning goals. They are aligned vertically to strengthen application of learning and depth of knowledge. If implemented effectively, these standards and outcomes will help students to understand and apply knowledge and skills necessary to thrive in a global economy and to be successful learners across other academic disciplines.

Learning Standards: Equity, Access, Inclusion, and Diversity

Computer science, among other STEM disciplines, can provide the knowledge and skills to empower individuals to create technologies with broad influence and impact. Women, underrepresented minorities, and people with disabilities are often missing in computer science classes, majors, and occupations. Limited access to technology due to geography or poverty can also restrict access and opportunities. A lack of diversity limits the scope of problems being addressed and the ability of new tools and technologies to reach multiple audiences.

One way to address this opportunity gap is by increasing access, inclusion, and opportunities for all students to learn computer science.

All students need to understand a world that is increasingly influenced by technology and to apply computing as a tool for learning and expression in a variety of disciplines and interests. Computer science and computational thinking, essential 21st Century Skills that increase a student's readiness for careers and college in any field, can be integrated into any discipline. The High School and Beyond Plan, required of all students to graduate, is the place to identify individual student goals for career, college, and life. Computer science offers a strong foundation for students to attain their goals.

Equity is embodied in the standards through both concepts and practices. For example, *Impacts of Computing* is a core concept aimed at promoting ideas about equity. *Fostering an Inclusive and Diverse Computing Culture* is an example of a core practice that promotes equity in K–12 computer science. Equity in computer science is not just about an equitable K–12 Computer Science Framework to implement the standards, but also about subsequent initiatives such as curriculum development, teacher preparation, access to tools and equipment, and integrated instruction.

Computer science courses and modules present a distinct opportunity to educate students about diversity, equity, and inclusion. As noted above, the standards and supporting framework provide explicit content about inclusive and diverse computing cultures. Students can engage in thoughtful interaction about the value of diversity while using computational thinking to develop computer

artifacts to solve real-world problems. Educators and students can challenge implicit bias, stereotypes about computer science, and narrow perspectives while learning about core concepts like networks and security, data analysis, and impacts of computing because the cross-cutting themes of equity and inclusion are embedded in the framework.

Computer Science K–12 Learning Standards

The 2015 Washington State Legislature required the adoption of nationally-recognized computer science standards. The enactment of this law coincided with the development of a national computer science framework by K12CS.org. The Computer Science K–12 Learning Standards reflect the recommendations of the K–12 Computer Science Framework, led by the Association for Computing Machinery, Code.org, Computer Science Teachers Association, Cyber Innovation Center, and National Math and Science Initiative in partnership with states and districts. The K–12 Computer Science Framework is endorsed by leading industry and educational organizations as well as K–12, higher education, and research leaders in the field of computer science education.

The standards are meant to establish a baseline literacy in computer science for all students and provide guidance for designing curriculum, assessments, and teacher preparation programs. It consists of five core concepts and seven core practices, as listed:

Core Concepts

1. Computing Systems
2. Networks and the Internet
3. Data and Analysis
4. Algorithms and Programming
5. Impacts of Computing

Core Practices

1. Fostering an Inclusive and Diverse Computing Culture
2. Collaborating
3. Recognizing and Defining Computational Problems
4. Developing and Using Abstractions
5. Creating Computational Artifacts
6. Testing and Refining
7. Communicating

The Computer Science K–12 Learning Standards and connected framework represent a vision in which all students, from a young age, engage in the concepts and practices of computer science to understand a world that is increasingly influenced by technology and to apply computing as a tool for learning and expression in a variety of disciplines and interests. From kindergarten through 12th grade, students will develop new approaches to problem solving that harness the power of computational thinking, while not only becoming users, but creators of computing technology.

Figure 1: Relationship between Framework Concepts and Practices.
Graphic from K–12 Computer Science Framework video. YouTube: https://youtu.be/CD0EIGfr950

Computer science also has strong connections to other disciplines, and is becoming increasingly important in the workplace. Many problems in science, engineering, health care, business, and other areas can be solved effectively with computers, but finding a solution requires both computer science expertise and knowledge of the particular application domain. Thus, computer scientists need to understand and often become proficient in other subjects.

Goal of the Standards

The Computer Science K–12 Learning Standards are based on the Computer Science Teachers Association's Interim K–12 Computer Science Standards, and define a set of standards that are supported by the K–12 Framework. The framework suggests steps that will be needed to enable their wide implementation. The standards introduce the principles and methodologies of computer science to all students, whether they are college bound or career bound after high school. The standards outlined in this document address the entire K–12 range. They complement existing K–12 computer science and information technology curricula where they are already established, especially the advanced placement (AP) computer science curricula (AP, 2010). Additionally, the standards complement existing curricula in other disciplines.

> *... the office of the superintendent of public instruction shall adopt computer science learning standards developed by a nationally recognized computer science education organization.*
>
> *-SHB 1813 (2015)*

Concepts in the Standards

The core concepts are categories that represent major content areas in the field of computer science.

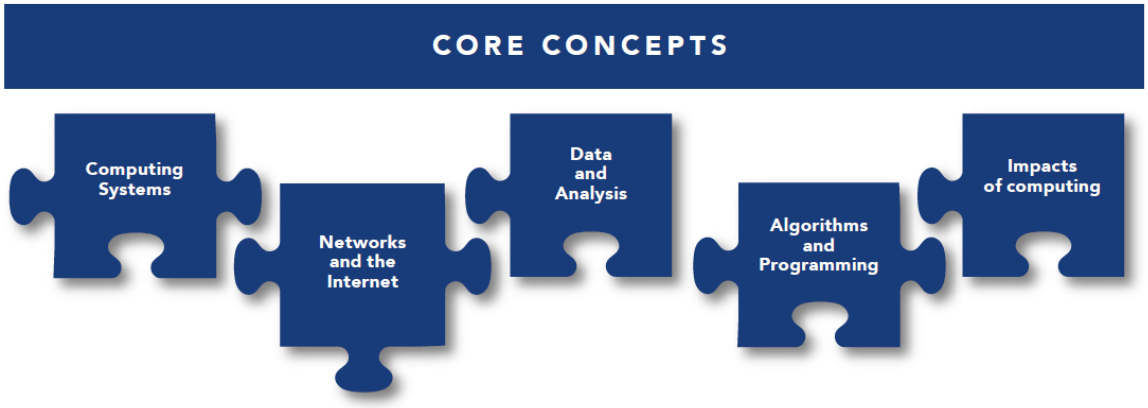

Figure 2: Concepts - K–12 Computer Science Framework. (2016). Retrieved from http://www.k12cs.org (CC BY NC SA 4.0).

Practices in the Standards

Practices are behaviors and ways of thinking that students will use as they learn and implement the various concepts described in the framework. For example, students will create computational artifacts to demonstrate and increase their knowledge of algorithms. Unlike the framework's concepts, the progressions of the practices are not delineated by grade bands.

Value of Concepts and Standards

The computer science concepts and practices will empower students to:

- Be informed citizens who can critically engage in public discussion on computer science related topics
- Develop as learners, users, and creators of computer science knowledge and artifacts
- Better understand the role of computing in the world around them
- Learn, perform, and express themselves in other subjects and interests
- Increase career and college readiness

The Computer Science Teachers Association collaborated with K12CS.org to align the development of Interim Computer Science Teachers Association K–12 Computer Science standards with the revision of the K–12 Computer Science Framework. This process intentionally paralleled the development of the Next Generation Science Standards, with a framework informing standards.

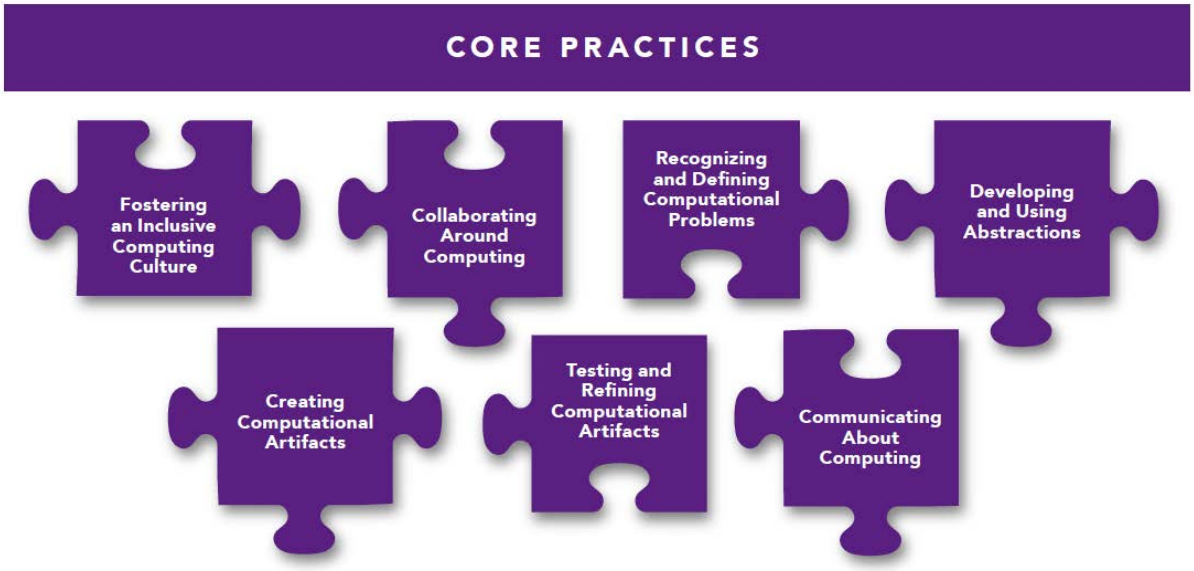

Figure 3: Practices- K–12 Computer Science Framework. (2016). Retrieved from http://www.k12cs.org (CC BY NC SA 4.0).

Computational Thinking

Computational Thinking, the human ability to formulate problems so that their solutions can be represented as computational steps or algorithms to be carried out by an information-processing agent (e.g., a computer), is central to the standards' practices and concepts.

Computational thinking is called out as an overarching practice reflected in a number of the core computer science practices. With its focus on abstraction, automation, and analysis, computational thinking is a core element of the broader discipline of computer science and for that reason it is interwoven through these computer science standards at all levels of K–12 learning.

Implementation of Grade-Level Bands

The grade-level bands associated with each learning standard are intended to provide teachers with the confidence to provide age-appropriate and accurate information and instruction that progresses in complexity from grade level to grade level. Competency for one grade level serves as a foundation for attaining competency of the bands for the next grade level. Teachers can use the grade-level bands as starting points for instruction and as checkpoints to ensure that the learning standards are taught and applied to the student's ability.

Teachers can use grade-level bands to:

- Develop lesson plans
- Establish specific and intentional learning objectives to guide teaching and learning
- Conduct ongoing formative and summative assessments to check student understanding and efficacy of instruction
- Integrate computational thinking into their curriculum
- Create an equitable environment

All curriculum in Washington is decided locally, within each district. Districts will determine how to incorporate the Computer Science K–12 Learning Standards into each grade level and integrate them into relevant high school courses leading to graduation.

An understanding of the fundamentals of computer science and its underlying problem-solving methodology of computational thinking is a valuable skill in our global economy. Not every student should become a computer scientist, but all students should have the opportunity to explore and create with computing. Learning standards are the foundation for what students should know and be able to do. How this learning occurs is up to districts to develop and teachers to impart every day in every classroom.

Organizations and Key Documents Referenced

M. Guzdial. Learner-centered design of computing education: Research on computing for everyone. Synthesis Lectures on Human-Centered Informatics, 8(6):1–165, 2015.

A Framework for K–12 Computer Science Education, https://k12cs.org.

K–12 Computer Science Framework (Video), https://www.youtube.com/watch?v=CD0EIGfr950.

Interim Computer Science Teachers Association K–12 Computer Science Standards (2016), https://c.ymcdn.com/sites/www.csteachers.org/resource/resmgr/Docs/Standards/2016StandardsRevision/INTERIM_StandardsFINAL_07222.pdf.

ISTE Standards, http://www.iste.org/standards/istestandards.

Employment Projections (Washington Employment Security Department) https://fortress.wa.gov/esd/employmentdata/reports-publications/industry-reports/employment-projections.

College Board's Computer Science Principles: https://securemedia.collegeboard.org/digitalServices/pdf/ap/ap-computer-science-principles-courseand-exam-description.pdf.

Legend for Identifiers

Unique Numbering System for the 2016 K–12 Computer Science Learning Standards
To help organize and track each individual standard, a unique identifier was developed. An example appears below:

Grades	Identifier	Computer Science K–12 Learning Standard	Framework Concept	Framework Practice
9–10	**3A-A-2-1**	Design and develop a software artifact working in a team.	Algorithms and Programming	Collaborating

Use the following legend to interpret the unique identifier for each Computer Science K–12 Learning Standard:

The identifier code corresponds to: **Level – Concept – Practice – Identifier**		
Identifier Code		**Key**
Levels	1A	Grades K–2
	1B	Grades 3–5
	2	Grades 6–8
	3A	Grades 9–10
	3B	Grades 11–12
Concepts	A	Algorithms and Programming
	C	Computing Systems
	D	Data and Analysis
	I	Impacts of Computing
	N	Networks and the Internet
Practices	1	Fostering an Inclusive Computing Culture
	2	Collaborating
	3	Recognizing and Defining Computational Problems
	4	Developing and Using Abstractions
	5	Creating Computational Artifacts
	6	Testing and Refining
	7	Communicating about Computing

Figure 4: Standards Identifier Code - Interim Computer Science Teachers Association K–12 Computer Science Standards (2016) Retrieved from http://www.csteachers.org

K–2	Level 1A
1A-A-7-1	Give credit when using code, music, or pictures (for example) that were created by others.
1A-A-5-2	Construct programs, to accomplish a task or as a means of creative expression, which include sequencing, events, and simple loops, using a block-based visual programming language, both independently and collaboratively (e.g., pair programming).
1A-A-5-3	Plan and create a design document to illustrate thoughts, ideas, and stories in a sequential (step-by-step) manner (e.g., story map, storyboard, sequential graphic organizer).
1A-A-4-4	Use numbers or other symbols to represent data (e.g., thumbs up/down for yes/no, color by number, arrows for direction, encoding/decoding a word using numbers or pictographs).
1A-A-3-5	Decompose (break down) a larger problem into smaller sub-problems with teacher guidance or independently.
1A-A-3-6	Categorize a group of items based on the attributes or actions of each item, with or without a computing device.
1A-A-3-7	Construct and execute algorithms (sets of step-by-step instructions) that include sequencing and simple loops to accomplish a task, both independently and collaboratively, with or without a computing device.
1A-A-6-8	Analyze and debug (fix) an algorithm that includes sequencing and simple loops, with or without a computing device.
1A-C-7-9	Identify and use software that controls computational devices (e.g., use an app to draw on the screen, use software to write a story or control robots).
1A-C-7-10	Use appropriate terminology in naming and describing the function of common computing devices and components (e.g., desktop computer, laptop computer, tablet device, monitor, keyboard, mouse, printer).
1A-C-6-11	Identify, using accurate terminology, simple hardware and software problems that may occur during use (e.g., app or program not working as expected, no sound, device won't turn on).
1A-D-7-12	Collect data over time and organize it in a chart or graph in order to make a prediction.
1A-D-4-13	Use a computing device to store, search, retrieve, modify, and delete information and define the information stored as data.
1A-D-4-14	Create a model of an object or process in order to identify patterns and essential elements (e.g., water cycle, butterfly life cycle, seasonal weather patterns).
1A-I-7-15	Compare and contrast examples of how computing technology has changed and improved the way people live, work, and interact.
1A-N-2-16	Use computers or other computing devices to connect with people using a network (e.g., the Internet) to communicate, access, and share information as a class.
1A-N-7-17	Use passwords to protect private information and discuss the effects of password misuse

3–5	Level 1B
1B-A-2-1	Apply collaboration strategies to support problem solving within the design cycle of a program.
1B-A-7-2	Use proper citations and document when ideas are borrowed and changed for their own use (e.g., using pictures created by others, using music created by others, remixing programming projects).
1B-A-5-3	Create a plan as part of the iterative design process, both independently and with diverse collaborative teams (e.g., storyboard, flowchart, pseudo-code, story map).
1B-A-5-4	Construct programs, in order to solve a problem or for creative expression, that include sequencing, events, loops, conditionals, parallelism, and variables, using a block-based visual programming language or text-based language, both independently and collaboratively (e.g., pair programming).
1B-A-5-5	Use mathematical operations to change a value stored in a variable.
1B-A-3-6	Decompose (break down) a larger problem into smaller sub-problems, independently or in a collaborative group.
1B-A-3-7	Construct and execute an algorithm (set of step-by-step instructions) that includes sequencing, loops, and conditionals to accomplish a task, both independently and collaboratively, with or without a computing device.
1B-A-6-8	Analyze and debug (fix) an algorithm that includes sequencing, events, loops, conditionals, parallelism, and variables.
1B-C-7-9	Model how a computer system works. [Clarification: Only includes basic elements of a computer system, such as input, output, processor, sensors, and storage.]
1B-C-7-10	Use appropriate terminology in naming internal and external components of computing devices and describing their relationships, capabilities, and limitations.
1B-C-6-11	Identify, using accurate terminology, simple hardware and software problems that may occur during use, and apply strategies for solving problems (e.g., reboot device, check for power, check network availability, close and reopen app).
1B-D-5-12	Create a computational artifact to model the attributes and behaviors associated with a concept (e.g., solar system, life cycle of a plant).
1B-D-5-13	Answer a question by using a computer to (e.g., sort, total and/or average, chart, graph) and analyze data that has been collected by the class or student.
1B-D-4-14	Use numeric values to represent non-numeric ideas in the computer (binary, ASCII, pixel attributes such as RGB).
1B-I-7-15	Evaluate and describe the positive and negative impacts of the pervasiveness of computers and computing in daily life (e.g., downloading videos and audio files, electronic appliances, wireless Internet, mobile computing devices, GPS systems, wearable computing).
1B-I-7-16	Generate examples of how computing can affect society, and also how societal values can shape computing choices.
1B-I-1-17	Seek out and compare diverse perspectives, synchronously or asynchronously, to improve a project.

3–5	Level 1B
1B-I-1-18	Brainstorm ways in which computing devices could be made more accessible to all users.
1B-I-1-19	Explain problems that relate to using computing devices and networks (e.g., logging out to deter others from using your account, cyberbullying, privacy of personal information, and ownership).
1B-N-7-20	Create examples of strong passwords, explain why strong passwords should be used, and demonstrate proper use and protection of personal passwords.
1B-N-4-21	Model how a device on a network sends a message from one device (sender) to another (receiver) while following specific rules.

6–8	Level 2
2-A-2-1	Solicit and integrate peer feedback as appropriate to develop or refine a program.
2-A-7-2	Compare different algorithms that may be used to solve the same problem, but one might be faster than the other. (e.g., different algorithms solve the same problem, but one might be faster than the other). [Clarification: Students are not expected to quantify these differences.]
2-A-7-3	Provide proper attribution when code is borrowed or built upon.
2-A-7-4	Interpret the flow of execution of algorithms and predict their outcomes. [Clarification: Algorithms can be expressed using natural language, flow and control diagrams, comments within code, and pseudocode.]
2-A-5-5	Design, develop, and present computational artifacts such as mobile applications that address social problems both independently and collaboratively.
2-A-5-6	Develop programs, both independently and collaboratively, that include sequences with nested loops and multiple branches. [Clarification: At this level, students may use block-based and/or text-based programming languages.]
2-A-5-7	Create variables that represent different types of data and manipulate their values.
2-A-4-8	Define and use procedures that hide the complexity of a task and can be reused to solve similar tasks. [Clarification: Students use and modify, but do not necessarily create, procedures with parameters.]
2-A-3-9	Decompose a problem into parts and create solutions for each part.
2-A-6-10	Use an iterative design process (e.g., define the problem, generate ideas, build, test, and improve solutions) to solve problems, both independently and collaboratively.
2-C-7-11	Justify the hardware and software chosen to accomplish a task (e.g., comparison of the features of a tablet vs. desktop, selecting which sensors and platform to use in building a robot or developing a mobile app).
2-C-4-12	Analyze the relationship between a device's computational components and its capabilities. [Clarification: Computing Systems include not only computers, but also cars, microwaves, smartphones, traffic lights, and flash drives.]
2-C-6-13	Use a systematic process to identify the source of a problem within individual and connected devices (e.g., follow a troubleshooting flow diagram, make changes to software to see if hardware will work, restart device, check connections, swap in working components).
2-D-7-14	Describe how different formats of stored data represent tradeoffs between quality and size. [Clarification: compare examples of music, text and/or image formats.]
2-D-7-15	Explain the processes used to collect, transform, and analyze data to solve a problem using computational tools (e.g., use an app or spreadsheet form to collect data, decide which data to use or ignore, and choose a visualization method.).
2-D-5-16	Revise computational models to more accurately reflect real-world systems (e.g., ecosystems, epidemics, spread of ideas).

6–8	Level 2
2-D-4-17	Represent data using different encoding schemes (e.g., binary, Unicode, Morse code, shorthand, student-created codes).
2-I-7-18	Summarize negative and positive impacts of using data and information to categorize people, predict behavior, and make recommendations based on those predictions (e.g., customizing search results or targeted advertising, based on previous browsing history, can save search time and limit options at the same time).
2-I-7-19	Explain how computer science fosters innovation and enhances nearly all careers and disciplines.
2-I-1-20	Provide examples of how computational artifacts and devices impact health and wellbeing, both positively and negatively.
2-I-1-21	Describe ways in which the Internet impacts global communication and collaborating.
2-I-1-22	Describe ethical issues that relate to computing devices and networks (e.g., equity of access, security and plagiarism), hacking, intellectual property, copyright, Creative Commons licensing.
2-I-6-23	Redesign a computational artifact to remove barriers to universal access (e.g., using captions on images, high contrast colors, and/or larger font sizes).
2-N-7-24	Summarize security risks associated with weak passwords, lack of encryption, insecure transactions, and persistence of data.
2-N-4-25	Simulate how information is transmitted as packets through multiple devices over the Internet and Networks.

9–10	Level 3A
3A-A-2-1	Design and develop a software artifact working in a team.
3A-A-2-2	Demonstrate how diverse collaborating impacts the design and development of software products (e.g., discussing real-world examples of products that have been improved through having a diverse design team or reflecting on their own team's development experience).
3A-A-7-3	Compare and contrast various software licensing schemes (e.g., open source, freeware, commercial).
3A-A-5-4	Design, develop, and implement a computing artifact that responds to an event (e.g., robot that responds to a sensor, mobile app that responds to a text message, sprite that responds to a broadcast).
3A-A-5-5	Use user-centered research and design techniques (e.g., surveys, interviews) to create software solutions
3A-A-5-6	Integrate grade-level appropriate mathematical techniques, concepts, and processes in the creation of computing artifacts.
3A-A-4-7	Understand the notion of hierarchy and abstraction in high-level languages, translation, instruction sets, and logic circuits.
3A-A-4-8	Deconstruct a complex problem into simpler parts using predefined constructs (e.g., functions and parameters and/or classes).
3A-A-4-9	Demonstrate the value of abstraction for managing problem complexity (e.g., using a list instead of discrete variables).
3A-A-3-10	Design algorithms using sequence, selection, and iteration.
3A-A-3-11	Explain and demonstrate how modeling and simulation can be used to explore natural phenomena (e.g., flocking behaviors, queueing, life cycles).
3A-A-6-12	Use a systematic approach and debugging tools to independently debug a program (e.g., setting breakpoints, inspecting variables with a debugger).
3A-C-7-13	Develop and apply criteria (e.g., power consumption, processing speed, storage space, battery life, cost, operating system) for evaluating a computer system for a given purpose (e.g., system specification needed to run a game, web browsing, graphic design or video editing).
3A-C-5-14	Create, extend, or modify existing programs to add new features and behaviors using different forms of inputs and outputs (e.g., inputs such as sensors, mouse clicks, data sets; outputs such as text, graphics, sounds).

9–10	Level 3A
3A-C-4-15	Demonstrate the role and interaction of a computer embedded within a physical system, such as a consumer electronic, biological system, or vehicle, by creating a diagram, model, simulation, or prototype.
3A-C-4-16	Describe the steps necessary for a computer to execute high compilation to machine language, interpretation, fetch-decode-execute https://www.cise.ufl.edu/~mssz/CompOrg/CDAintro.html.
3A-D-5-17	Create computational models that simulate real-world systems (e.g., ecosystems, epidemics, spread of ideas).
3A-D-4-18	Convert between binary, decimal, and hexadecimal representations of data (e.g., convert hexadecimal color codes to decimal percentages, ASCII/Unicode representation).
3A-D-4-19	Analyze the representation tradeoffs among various forms of digital information (e.g., lossy versus lossless compression, encrypted vs. unencrypted, various image representations).
3A-D-3-20	Discuss techniques used to store, process, and retrieve different amounts of information (e.g., files, databases, data warehouses).
3A-D-3-21	Apply basic techniques for locating and collecting small- and large-scale data sets (e.g., creating and distributing user surveys, accessing real-world data sets).
3A-I-2-22	Debate the social and economic implications associated with ethical and unethical computing practices (e.g., intellectual property rights, hacktivism, software piracy, diesel emissions testing scandal, new computers shipped with malware).
3A-I-7-23	Compare and contrast information access and distribution rights.
3A-I-7-24	Discuss implications of the collection and large-scale analysis of information about individuals (e.g., how businesses, social media, and government collect and use personal data).
3A-I-7-25	Describe how computation shares features with art and music by translating human intention into an artifact.
3A-I-1-26	Compare and debate the positive and negative impacts of computing on behavior and culture (e.g., evolution from hitchhiking to ridesharing apps, online accommodation rental services).
3A-I-1-27	Demonstrate how computing enables new forms of experience, expression, communication, and collaborating.
3A-I-1-28	Explain the impact of the digital divide (i.e., uneven access to computing, computing education, and interfaces) on access to critical information.
3A-I-6-29	Redesign user interfaces (e.g., webpages, mobile applications, animations) to be more inclusive, accessible, and minimizing the impact of the designer's inherent bias.

9–10	Level 3A
3A-N-7-30	Describe key protocols and underlying processes of Internet-based services (e.g., http/https and SMTP/IMAP, routing protocols).
3A-N-4-31	Illustrate the basic components of computer networks (e.g., draw logical and topological diagrams of networks including routers, switches, servers, and end user devices; create model with string and paper).
3A-N-1-32	Compare and contrast multiple viewpoints on cybersecurity (e.g., from the perspective of security experts, privacy advocates, the government).
3A-N-3-33	Explain the principles of information security (confidentiality, integrity, availability) and authentication techniques.
3A-N-3-34	Use simple encryption and decryption algorithms to transmit/receive an encrypted message.
3A-N-6-35	Identify digital and physical strategies to secure networks and discuss the tradeoffs between ease of access and need for security.

11–12	Level 3B
3B-A-2-1	Use version control systems, integrated development environments (IDEs), and collaborating tools and practices (code documentation) in a group software project.
3B-A-2-2	Demonstrate software life cycle processes (e.g., spiral, waterfall) by participating on software project teams (e.g., community service project with real-world clients).
3B-A-7-3	Modify an existing program to add additional functionality and discuss intended and unintended implications (e.g., breaking other functionality).
3B-A-7-4	Explain security issues that might lead to compromised computer programs (e.g., circular references, ambiguous program calls, lack of error checking and field size checking).
3B-A-7-5	Compare a variety of programming languages and identify features that make them useful for solving different types of problems and developing different kinds of systems (e.g., declarative, logic, parallel, functional, compiled, interpreted, real-time).
3B-A-7-6	Describe how artificial intelligence drives many software and physical systems (e.g., autonomous robots, computer vision, pattern recognition, text analysis).
3B-A-5-7	Decompose a problem by creating new data types, functions, or classes.
3B-A-5-8	Demonstrate code reuse by creating programming solutions using libraries and APIs (e.g., graphics libraries, maps API).
3B-A-5-9	Implement an AI algorithm to play a game against a human opponent or solve a problem.
3B-A-5-10	Develop programs for multiple computing platforms (e.g., computer desktop, web, mobile).
3B-A-4-11	Critically analyze classic algorithms (e.g., sorting, searching) and use in different contexts, adapting as appropriate.
3B-A-4-12	Evaluate algorithms (e.g., sorting, searching) in terms of their efficiency, correctness, and clarity.
3B-A-4-13	Compare and contrast fundamental data structures and their uses (e.g., lists, maps, arrays, stacks, queues, trees, graphs).
3B-A-4-14	Discuss issues that arise when breaking large-scale problems down into parts that must be processed simultaneously on separate systems (e.g., cloud computing, parallelization, concurrency).
3B-A-3-15	Provide examples of computationally solvable problems and difficult-to-solve problems.
3B-A-3-16	Explain the value of heuristic algorithms (discovery methods) to approximating solutions for difficult-to-solve computational problems.

11–12	Level 3B
3B-A-3-17	Decompose a large-scale computational problem by identifying generalizable patterns and applying them in a solution.
3B-A-3-18	Illustrate the flow of execution of a recursive algorithm.
3B-A-3-19	Describe how parallel processing can be used to solve large problems (e.g., SETI at Home, FoldIt).
3B-A-3-20	Develop and use a series of test cases to verify that a program performs according to its design specifications.
3B-A-6-21	Evaluate key qualities of a program (e.g., correctness, usability, readability, efficiency, portability, scalability) through a process such as a code review.
3B-C-7-22	Explain the role of operating systems (e.g., how programs are stored in memory, how data is organized/retrieved, how processes are managed and multi-tasked).
3B-C-7-23	Identify the functionality of various categories of hardware components and communication between them (e.g., physical layers, logic gates, chips, input and output devices).
3B-D-4-24	Use data analysis to identify significant patterns in complex systems (e.g., take existing data sets and make sense of them).
3B-D-4-25	Discuss how data sequences (e.g., binary, hexadecimal, octal) can be interpreted in a variety of forms (e.g., instructions, numbers, text, sound, image).
3B-D-4-26	Evaluate the ability of models and simulations to formulate, refine, and test hypotheses.
3B-D-4-27	Identify mathematical and computational patterns through modeling and simulation (e.g., regression, Runge-Kutta, queueing theory, discrete event simulation).
3B-D-1-28	Use various data collection techniques for different types of problems (e.g., mobile device, GPS, user surveys, embedded system sensors, open data sets, social media data sets).
3B-D-3-29	Explore security policies by implementing and comparing encryption and authentication strategies (e.g., secure coding, safeguarding keys).
3B-1-7-30	Develop criteria to evaluate the beneficial and harmful effects of computing innovations on people and society.
3B-I-5-31	Select, observe, and contribute to global Collaborating in the development of a computational artifact (e.g., contribute the resolution of a bug in an open-source project hosted on GitHub).

11–12	Level 3B
3B-I-1-32	Design and implement a study that evaluates or predicts how computation has revolutionized an aspect of our culture and how it might evolve (e.g., education, healthcare, art/entertainment, energy).
3B-I-1-33	Debate laws and regulations that impact the development and use of software.
3B-I-1-34	Evaluate the impact of equity, access, and influence on the distribution of computing resources in a global society.
3B-N-4-35	Simulate and discuss the issues (e.g., bandwidth, load, delay, topology) that impact network functionality (e.g., use free network simulators).

Computer Science Glossary

The following glossary includes definitions of terms used in the statements in the K–12 Computer Science Framework. These terms are intended to increase teacher understanding and decrease biased language.

abstraction *(process):* The process of reducing complexity by focusing on the main idea. By hiding details irrelevant to the question at hand and bringing together related and useful details, abstraction reduces complexity and allows one to focus on the problem. In elementary classrooms, abstraction is hiding unnecessary details to make it easier to think about a problem.

(product): A new representation of a thing, a system, or a problem that helpfully reframes a problem by hiding details irrelevant to the question at hand. [MA-DLCS]

(Code.org K–5) Pulling out specific differences to make one solution work for multiple problems.

algorithm: A step-by-step process to complete a task.

A list of steps to finish a task. A set of instructions that can be performed with or without a computer. For example, the collection of steps to make a peanut butter and jelly sandwich is an algorithm. (Code.org K–5)

app: A type of application software designed to run on a mobile device, such as a smartphone or tablet computer (also known as a mobile application). [Techopedia]

artifact: Anything created by a human. *See "computational artifact" for the computer science-specific definition.*

ASCII: (American Standard Code for Information Interchange) is the most common format for text files in computers and on the Internet. In an ASCII file, each alphabetic, numeric, or special character is represented with a 7-bit binary number (a string of seven 0s or 1s). 128 possible characters are defined.

automation: To link disparate systems and software in such a way that they become self-acting or self-regulating.

backup: The process of making copies of data or data files to use in the event the original data or data files are lost or destroyed. [Techopedia]

binary: A method of encoding data using two symbols (usually 1 and 0). To illustrate binary encoding, we can use any two symbols. [MA-DLCS]

A way of representing information using only two options. (Code.org K–5)

Block-based programming language: (Code.org K–5) Any programming language that lets users create programs by manipulating "blocks" or graphical programing elements, rather than writing code using text. Examples include Code Studio, Scratch, and Swift. (Sometimes called visual coding, drag and drop programming, or graphical programming blocks)

bug: An error in a software program. It may cause a program to unexpectedly quit or behave in an unintended manner. [TechTerms] The process of removing errors (bugs) is called debugging.

An error in a program that prevents the program from running as expected. (Code.org K–5)

cloud: Remote servers that store data and are accessed from the Internet. [Techopedia]

code: Any set of instructions expressed in a programming language. [MA-DLCS] One or more commands or algorithm(s) designed to be carried out by a computer. (Code.org K–5) See also: program

command: An instruction for the computer. Many commands put together make up algorithms and computer programs. (Code.org K–5)

computational artifact: Anything created by a human using a computational thinking process and a computing device. A computational artifact can be, but is not limited to, a program, image, audio, video, presentation, or web page file.

computational thinking: Mental processes and strategies that include: decomposition, pattern matching, abstraction, algorithms (decomposing problems into smaller, more manageable problems, finding repeating patterns, abstracting specific differences to make one solution work for multiple problems, and creating step-by-step algorithms). (Code.org K–5)

computer science: Using the power of computers to solve problems. (Code.org K–5)

conditionals: Statements that only run under certain conditions or situations. (Code.org K–5)

data: Information. Often, quantities, characters, or symbols that are the inputs and outputs of computer programs. (Code.org K–5)

debugging: Finding and fixing errors in programs. (Code.org K–5)

decompose: Break a problem down into smaller pieces. (Code.org K–5)

decryption: The process of taking encoded or encrypted text or other data and converting it back into text that you or the computer can read and understand.

Digital divide: the gulf between those who have ready access to computers and the Internet, and those who do not.

encryption: The process of encoding messages or information in such a way that only authorized parties can read it.

event: An action that causes something to happen. (Code.org K–5)

execution: The process of executing an instruction or instruction set.

for loop: A loop with a predetermined beginning, end, and increment (step interval) (Code.org K–5)

function: A type of procedure or routine. Some programming languages make a distinction between a function, which returns a value, and a procedure, which performs some operation, but does not return

a value. [MA-DLCS] *Note: This definition differs from that used in math.* A piece of code that you can easily call over and over again. Functions are sometimes called 'procedures.' (Code.org K–5)

GPS: Abbreviation for "Global Positioning System." GPS is a satellite navigation system used to determine the ground position of an object. [TechTerms]

hacking: Appropriately applying ingenuity (from "The Meaning of Hack"), cleverly solving a programming problem (the New Hacker's Dictionary), and using a computer to gain unauthorized access to data within a system. [MA-DLCS]

hardware: The physical components that make up a computing system, computer, or computing device. [MA-DLCS]

hierarchy: An organizational structure in which items are ranked according to levels of importance. [TechTarget]

HTTP: (Hypertext Transfer Protocol) is the set of rules for transferring files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.

HTTPS: encrypts and decrypts user page requests as well as the pages that are returned by the Web server. The use of HTTPS protects against eavesdropping and man-in-the-middle attacks.

input: The signals or instructions sent to a computer. [Techopedia]

Internet: The global collection of computer networks and their connections, all using shared protocols to communicate [CAS-Prim] A group of computers and servers that are connected to each other. (Code.org K–5)

iterative: Involving the repeating of a process with the aim of approaching a desired goal, target, or result. [MA-DLCS]

logic (Boolean): Boolean logic deals with the basic operations of truth values: AND, OR, NOT and combinations thereof. [FOLDOC]

loop: A programming structure that repeats a sequence of instructions as long as a specific condition is true. [TechTerms]

looping: Repetition, using a loop. The action of doing something over and over again. (Code.org K–5)

lossless: data compression without loss of information.

lossy: data compression in which unnecessary information is discarded.

memory: Temporary storage used by computing devices. [MA-DLCS]

model: A representation of (some part of) a problem or a system. (Modeling (v): the act of creating a model) [MA-DLCS] *Note: This definition differs from that used in science.*

network: A group of computing devices (personal computers, phones, servers, switches, routers, and so on) connected by cables or wireless media for the exchange of information and resources.

nested loop: A loop within a loop, an inner loop within the body of an outer one.

operating system: Software that communicates with the hardware and allows other programs to run. An operating system (or "OS") is comprised of system software, or the fundamental files a computer needs to boot up and function. Every desktop computer, tablet, and smartphone includes an operating system that provides basic functionality for the device. [TechTerms]

operation: An action, resulting from a single instruction, that changes the state of data. [Dictionary.com]

packets: Small chunks of information that have been carefully formed from larger chunks of information.

pair programming: A technique in which two developers (or students) team together and work on one computer. [TechTarget] The terms "driver" and "navigator" are often used for the two roles. In a classroom setting, teachers often specify that students switch roles frequently (or within a specific period of time).

paradigm (programming): A theory or a group of ideas about how something should be done, made, or thought about. A philosophical or theoretical framework of any kind. [Merriam-Webster] Common programming paradigms are object-oriented, functional, imperative, declarative, procedural, logic, and symbolic. [DC, Wikipedia]

parallelism: The simultaneous execution on multiple processors of different parts of a program.

parameter: A special kind of variable used in a procedure to refer to one of the pieces of data provided as input to the procedure. These pieces of data are called arguments. An ordered list of parameters is usually included in the definition of a subroutine so each time the subroutine is called, its arguments for that call can be assigned to the corresponding parameters. [MA-DLCS]

An extra piece of information that you pass to the function to customize it for a specific need. (Code.org)

pattern matching: Finding similarities between things. (Code.org K–5)

persistence: Trying again and again, even when something is very hard. (Code.org K–5)

piracy: The illegal copying, distribution, or use of software. [TechTarget]

procedure: An independent code module that fulfills some concrete task and is referenced within a larger body of source code. This kind of code item can also be called a function or a subroutine. The fundamental role of a procedure is to offer a single point of reference for some small goal or task that the developer or programmer can trigger by invoking the procedure itself. A procedure may also be referred to as a function, subroutine, routine, method or subprogram. [Techopedia]

processor: The hardware within a computer or device that executes a program. The CPU (central processing unit) is often referred to as the brain of a computer.

program; programming *(n)*: A set of instructions that the computer executes in order to achieve a particular objective. [MA-DLCS]

program *(v)*: To produce a program by programming. An algorithm that has been coded into something that can be run by a machine. (Code.org K–5)

programming: The craft of analyzing problems and designing, writing, testing, and maintaining programs to solve them. [MA-DLCS] The art of creating a program. (Code.org K–5)

protocol: The special set of rules that end points in a telecommunication connection use when they communicate. Protocols specify interactions between the communicating entities. [TechTarget]

prototype; prototype: An early approximation of a final product or information system, often built for demonstration purposes. [TechTarget, Techopedia]

pseudocode: A detailed yet readable description of what a computer program or algorithm must do, expressed in a formally-styled natural language rather than in a programming language. [TechTarget]

RGB: (red, green, and blue) Refers to a system for representing the colors to be used on a computer display. Red, green, and blue can be combined in various proportions to obtain any color in the visible spectrum.

routing; router; routing: Establishing the path that data packets traverse from source to destination. A device or software that determines the routing for a data packet. [TechTarget]

run program: Cause the computer to execute the commands you've written in your program. (Code.org K–5)

security: The protection against access to, or alteration of, computing resources, through the use of technology, processes, and training. [TechTarget]

servers: Computers that exist only to provide things to others. (Code.org K–5)

simulate: to imitate the operation of a real world process or system over time.

simulation: Imitation of the operation of a real world process or system over time. [MA-DLCS]

software: Programs that run on a computer system, computer, or other computing device.

SMTP: the standard protocol for sending emails across the Internet. The communication between mail servers uses port 25.

IMAP: a mail protocol used for accessing email on a remote web server from a local client.

storage: A place (usually a device) into which data can be entered, in which it can be held, and from which it can be retrieved at a later time. [FOLDOC] A process through which digital data is saved within a data storage device by means of computing technology. Storage is a mechanism that enables a computer to retain data, either temporarily or permanently. [Techopedia]

string: A sequence of letters, numbers, and/or other symbols. A string might represent a name, address, or song title. Some functions commonly associated with strings are length, concatenation, and substring. [TechTarget]

structure: A general term used in the framework to discuss the concept of encapsulation without specifying a particular paradigm.

subroutine: A callable unit of code, a type of procedure.

switch: A high-speed device that receives incoming data packets and redirects them to their destination on a local area network (LAN). [Techopedia]

system: A collection of elements or components that work together for a common purpose. [TechTarget] A collection of computing hardware and software integrated for the purpose of accomplishing shared tasks.

topology: The physical and logical configuration of a network; the arrangement of a network, including its nodes and connecting links. A logical topology is how devices appear connected to the user. A physical topology is how they are actually interconnected with wires and cables. [PC Magazine]

troubleshooting: A systematic approach to problem solving that is often used to find and resolve a problem, error, or fault within software or a computer system. [Techopedia, TechTarget]

user: A person for whom a hardware or software product is designed (as distinguished from the developers). [TechTarget]

variable: A symbolic name that is used to keep track of a value that can change while a program is running. Variables are not just used for numbers. They can also hold text, including whole sentences ("strings"), or the logical values "true" or "false." A variable has a data type and is associated with a data storage location; its value is normally changed during the course of program execution. [CAS-Prim, Techopedia] A placeholder for a piece of information that can change (Code.org K–5)

wearable computing: Miniature electronic devices that are worn under, with or on top of clothing.

Note: This definition differs from that used in math.

Key to sources of multiple definitions in this glossary:

CAS-Prim: Computing at School. Computing in the national curriculum: A guide for primary teachers (http://www.computingatschool.org.uk/data/uploads/CASPrimaryComputing.pdf)

Code.org: Creative Commons License (CC BY-NC-SA 4.0) (https://code.org/curriculum/docs/k-5/glossary)

Computer Science Teachers Association: CSTA K–12 Computer Science Standards (2011) https://csta.acm.org/Curriculum/sub/K12Standards.html

FOLDOC: Free On-Line Dictionary of Computing. (http://foldoc.org/)

MA-DLCS: Massachusetts Digital Literacy and Computer Science Standards, Glossary (Draft, December 2015)

NIST/DADS: National Institute of Science and Technology Dictionary of Algorithms and Data Structures. (https://xlinux.nist.gov/dads//)

Techopedia: Techopedia. (https://www.techopedia.com/dictionary)

TechTarget: TechTarget Network. (http://www.techtarget.com/network)

TechTerms: Tech Terms Computer Dictionary. (http://www.techterms.com)

FINAL BILL REPORT: SHB 1813

C 3 L 15 E1 Synopsis as Enacted

Brief Description: Expanding computer science education.

Sponsors: House Committee on Appropriations (originally sponsored by Representatives Hansen, Magendanz, Reykdal, Muri, Tarleton, Zeiger, Lytton, Haler, Senn, Harmsworth, Tharinger, Young, Walkinshaw, Stanford, S. Hunt and Pollet).

House Committee on Education
House Committee on Appropriations
Senate Committee on Early Learning & K–12 Education

Background:

Endorsements.
There are several pathways to endorsement and different types of endorsements. For example, academic endorsements and Career and Technical Education (CTE) endorsements differ—a CTE endorsed teacher may only teach CTE courses, and these courses often will not apply toward core education requirements. There is no academic endorsement for computer science, only a CTE endorsement, which teachers may obtain by demonstrating to a teacher preparation program that they have experience in the field and have met the program's requirements.

Conditional Scholarship for Educators.
A conditional scholarship is a loan that is forgiven in whole or in part in exchange for service as a certificated teacher at a K–12 public school. The state forgives one year of loan obligation for every two years a recipient teaches in a Washington K–12 public school. When a recipient fails to continue with the required course of study or teaching obligation, the recipient must repay the remaining loan principal with interest.

The Retooling Mathematics and Sciences Conditional Scholarship Program requires a K–12 teacher, or certificated elementary educator who is not employed in a position requiring an elementary education certificate, to pursue an endorsement in math or science to be eligible for the program. The conditional scholarship amount is determined by the Student Achievement Council, may not exceed $3,000 per year, and is applied to the cost of tuition, fees, and educational expenses.

This analysis was prepared by non-partisan legislative staff for the use of legislative members in their deliberations. This analysis is not a part of the legislation nor does it constitute a statement of legislative intent.

Summary:

Endorsements and Standards.
The OSPI and the Professional Educator Standard Board (PESB) must adopt computer science learning standards developed by a nationally recognized computer science education organization. The PESB must also develop standards for a K–12 computer science endorsement, which must facilitate dual endorsement in computer science and mathematics, science, or another related high-demand endorsement.

Conditional Scholarship for Educators.
The Retooling to Teach Mathematics and Sciences Conditional Scholarship Program is renamed the Educator Retooling Conditional Scholarship Program. A K–12 teacher, or certificated elementary educator who is not employed in a position requiring an elementary education certificate, may qualify for the conditional scholarship program by pursuing an endorsement in a subject or geographic endorsement shortage area, as defined by the Professional Educator Standards Board.

Votes on Final Passage:

House	91	7

First Special Session

House	88	4
Senate	43	0

Effective: August 27, 2015

Acknowledgements

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Download this material in PDF at http://www.k12.wa.us/CurriculumInstruct/learningstandards.aspx.

Please refer to this document number for quicker service: 16-0075.

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