Idaho K-12 Content Computer Science Standards White Paper

This white paper is a companion to the "Idaho K-12 Computer Science Standards." It provides motivation and rationale for the standards and describes their development process. This document also adds transparency for the standards development process by providing historical reference and rationale for the content of the standards. It is intended to provide context for the standards.

What is Computer Science?

Computer Science is an established discipline at the collegiate level. The foundational concepts of Computer Science permeates all work and play in the digital world that we live in.

"What would we like our children- the general public of the future—to learn about computer science in schools? We need to do away with the myth that computer science is about computers. Computer science is no more about computers than astronomy is about telescopes, biology is about microscopes or chemistry is about beakers and test tubes. Science is not about tools, it is about how we use them and what we find out when we do" [2]. Engineering deals precisely with the notion of "how to." Science and Mathematics deal precisely with the notion of "what is." Computer Science deals with both aspects of computation and information. While Computer Science can be defined in various ways, the following definition is the one the working group has chosen to use.

"Computer science is the scientific and engineering approach to computation, as well as its applications and impact. It is the systematic study of the feasibility, structure, expression, and mechanization of the methodical procedures (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information" [1].

Computer Science broadly encompasses data, algorithms, programming languages, and computational systems. Some of the major subspecialties of computer science are algorithms and

data structures, programming methodology, programming language design and implementation, software engineering, computer architecture, operating systems, database systems, networks and communications, parallel computing, distributed systems, human-computer interaction, artificial intelligence, secure and dependable systems, theory of computation, and computer graphics.

The Idaho K-12 Computer Science standards are organized by grade bands (K-2, 3-5, K-5, 6-8, 9-10, 11-12 and 9-12) and the five Core Computer Science Concepts shown below. It is intentional that some of the grade bands overlap. The standards are tagged with the seven Computational Thinking Framework practices shown below to match the practices to the concepts. The concepts and practices are borrowed from the 2016 K-12 CS Framework at k12cs.org [3]. Also included is a column for the designation of ISTE (International Society for Technology Education) Standards [5] as they align with the content standards for Computer Science.

The 5 Core Computer Science concepts:
1. Devices
2. Networks and Communication
3. Data and Analysis
4. Algorithms and Programming
5. Impact of Computing

The 7 Computational Thinking practices:
1. Recognizing and Representing Computational Problems
2. Developing and using Abstractions
3. Creating Computational Artifacts
4. Testing and Iteratively Refining
5. Fostering an Inclusive Computing Culture
6. Communicating about Computing
7. Collaborating around Computing

International Society for Technology Education (ISTE) Standards:
1. Creativity and Innovation
2. Communication and Collaboration
3. Research and Information Fluency
4. Critical Thinking, Problem Solving, and Decision Making
5. Digital Citizenship
6. Technology Operations and Concepts

The Purpose of the Standards

Computer Science is a field of study that will help to prepare students to meet future college and career goals. There are many jobs that require the understanding of Computer Science concepts and skills, however, all Idahoans can benefit from the computational thinking that is incorporated into these standards. The development of the Computer Science standards will move the students from

being consumers of technology to being able to understand and create new technologies of the future.

The standards prioritize, clarify, and build upon frameworks developed by professional organizations, educators, and industry. It is not an exhaustive list of everything in Computer Science that can be learned within a K-12 pathway, but instead describes what it means to be *literate* in Computer Science.

The standards are not curriculum. Curriculum is determined by the LEA (Local Education Agency). The standards clarify the learning outcomes of students. The standards inform teachers of what students should know, understand, or be able to do. Teachers can create "I can" statements with student friendly language from the standards. These are the minimum standards for Computer Science education. The LEA may include additional standards when writing curriculum depending on course offerings and the needs of students. Educators can use the standards in a variety of creative ways.

Current Status of Computer Science in Idaho

Idaho's current state of Computer Science education in K-12 is unstructured, disjointed, and uneven. As a result of not having a cohesive set of Idaho Computer Science Standards, teachers grasp from various resources and standards, which may not align across the state. This causes a lack of parity and equality for Idaho's students, as well as their access to Computer Science education. Having a uniform set of Computer Science standards will provide continuity of K-12 Computer Science education offerings throughout the state. Benefits will continue through higher education, and ultimately industry, business, and commerce of Idaho as more competent and well-educated graduates fulfill positions throughout the state.

According to the Conference Board (used by the Idaho Department of Labor), there are currently around 1300 unfilled open jobs in the state of Idaho for computer science related professions, many of which can be attributed to a lack of qualified candidates [6]. Not only is this challenging for potential employers, but also affects our state revenues in potential taxes with salaries averaging around $70,000. For the benefit of our citizens, students' education, as well as the future of computer science and the technology industry in our state, creating these standards is an important step.

The Standards Creation Process

The standards were built on a progression of skills that can be accomplished using a variety of tools and in some cases limited access to computers and the internet. Several existing Computer Science and related standards from CSTA (Computer Science Teachers Association), ISTE (International Society for Technology in Education), Florida Department of Education, Idaho CTE Programming Standards, Teacher Preparation Standards for Initial Certification in Computer Science, and Idaho Core Standards were reviewed and considered.

The working group chose the CSTA 2016 Computer Science draft standards [4], which aligns with the new K-12 CS Framework. The K-12 CS Framework draft is steered by 5 organizations: ACM (Association for Computing Machinery), CIC (Cyber Innovation Center), Code.org, CSTA, and NMSI (National Math+Science Initiative). The K-12 CS framework provides overarching, high-level guidance per grade bands, while the standards provide detailed student performance expectations at particular grade levels. The framework was considered as an input for the standards development process.

The CSTA draft standards were chosen for the following reasons:

- The working group felt that the CSTA draft standards, based on the K-12 CS Framework, were the best match for Idaho.

- They were the most up to date standards with input from a variety of educators, industry, and professional organizations.

- The CSTA standards (and the K-12 CS Framework) had input from various relevant organizations and industry:
  ○ Several states (MD, CA, IN, IA, AR, UT, ID, NE, GA, WA, NC)
  ○ Large school districts (NYC, Chicago, San Francisco)
  ○ Technology companies (Microsoft, Google, Apple)
  ○ Organizations (Code.org, ACM, CSTA, ISTE, MassCAN, CSNYC), and individuals (higher ed faculty, researchers, K-12 teachers, and administrators)
  ○ There was Idaho representation within the CSTA group

The working group evaluated and adapted the 2016 draft of the CSTA K-12 CS Standards with consideration of the following:

  ○ Is the standard appropriate for Idaho?
  ○ Is the standard appropriate for the given grade level?
  ○ Is the standard measureable?
  ○ Are there areas that we want to add that are not covered in the standards?
  ○ Does the standard need an example for clarification?
  ○ What needs to be removed, rewritten, or repositioned?
  ○ Do the standards parallel what occurs in disciplines such as science, mathematics, and language arts?

The working group customized the CTA standards for Idaho using the above questions as a guide. This was done over four days of intense face to face discussion as well as offline email exchanges. The working group made several improvements and changes in the draft CSTA standards. These modification were also submitted back to the CSTA for incorporation into the national standards.

Once the draft of the proposed standards was ready, a survey was sent to individuals in industry, elementary, secondary and postsecondary educators, and other interested parties to solicit input. The

working group received over fifty surveys. The working group assessed and modified the standards based on the feedback.

Supporting Resources and References

1. Computer Science. In *Wikipedia*. Retrieved on 4/21/2016 from https://en.wikipedia.org/wiki/Computer_science
2. Michael R. Fellows, Ian Parberry. "SIGACT trying to get children excited about CS." Computing Research News. January 1993.
3. A Framework for K-12 Computer Science Education, https://k12cs.org.
4. CSTA K-12 CS Standards (Draft, 2016)
5. ISTE Standards, http://www.iste.org/standards/iste-standards.
6. Software occupations in demand (Idaho Department of Labor) https://labor.idaho.gov/publications/software-occupations-in-demand.pdf

The K-12 Idaho Computer Science Standards Working Group

Scott Cook, Director of Academic Services, Idaho SDE (**Facilitator**)
Tim Andersen, Computer Science Faculty, Boise State University
Todd Bigelow, Sr. Manager (Product Engineering), ON Semiconductors
Chris Conant, Morley Nelson Elementary School, Boise School District
Ernie Covelli, Program Manager (Software Engineering), HP, Boise (retired)
Marita Diffenbaugh, Professional Development Specialist, Idaho Digital Learning Academy
Allen Hancock, Centennial Elementary School, Lewiston Independent School District
Robert B. Heckendorn, Computer Science Faculty, University of Idaho
Amit Jain, Computer Science Faculty, Boise State University
Ashlee Kolar, Math and Science Teacher, Syringa Middle School, Caldwell School District
Angie Martinez, Director of Curriculum, Teaching, and Learning, Blaine County School District
Heidi Rogers, CEO/Executive Director, Northwest Council for Computer Education (NCCE)
Jesse Ronnow, Senior Vice President, Zions Bank
Robert Schreiber, Physics and Computer Science Teacher, Treasure Valley Math & Science Center
Frederick T. Sheldon, Computer Science Faculty, University of Idaho
Justin Touchstone, Program Manager, Engineering and Technology Ed., Idaho Division of Career and Technical Education