Reimagining CS Pathways
High School and Beyond

Interim Report #1

Defining Essential CS Content
for All High School Graduates

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Table of Contents

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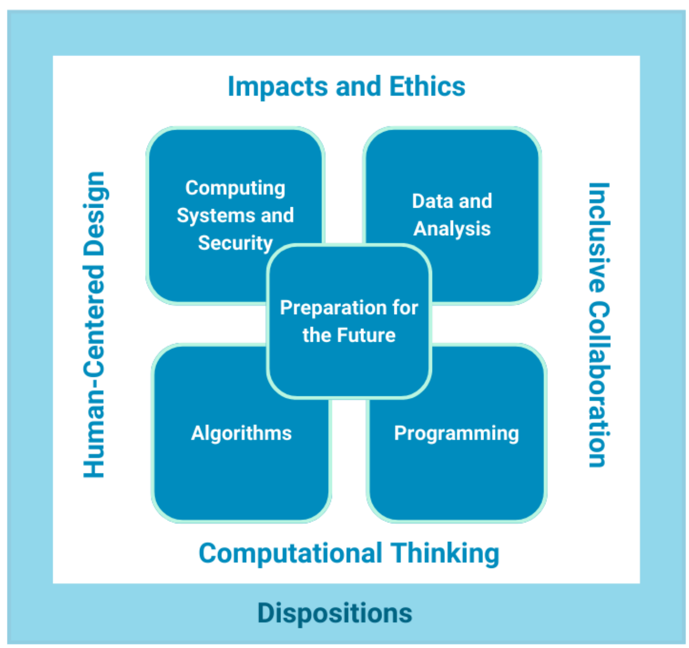
Executive Summary

Coming years are likely to see rapid changes that will affect computing, including growing interest in artificial intelligence (AI), more states with computer science (CS) high school graduation requirements, and more diversity among CS students. To prepare for these and other changes, *Reimagining CS Pathways: High School and Beyond* is exploring how CS should be reenvisioned for high school students. The project seeks to develop community definitions for what CS content is essential for all high school students and what pathways for continued learning beyond that essential content should exist. The project has several phases, and this report describes the first phase, which involved an in-person convening, focus groups, interviews, and other feedback focused on defining essential CS content for all high school students.

This phase was not without its challenges: participants found it difficult to anticipate what CS skills would be needed in life and career in the future, given the rapid pace of technological change. The project team found it challenging to synthesize the recommended CS content into coherent categories in a way that minimized gaps and overlaps.

While there was some variety among participants' suggestions for essential CS content, there was broad and consistent support for emphasizing the development of an inclusive computing culture and exposing students to societal and ethical implications of CS. In terms of technical content, participants placed a higher priority on algorithms and computational thinking than on programming skills. They also emphasized the importance of AI and understanding career options that involve computing.

This graphic illustrates the final product of this work. *Dispositions* (e.g., persistence, reflectiveness, creativity) surround all other elements. Five Topic Areas were identified: *Computing Systems and Security, Data and Analysis, Preparation for the Future, Algorithms, and Programming.* Crosscutting these five Topic Areas are *Impacts and Ethics, Inclusive Collaboration, Computational Thinking,* and *Human-Centered Design.*



This report describes these elements in more detail, including specific knowledge and skills in each Topic Area that were prioritized by participants.

1. Introduction

The year is 2035, and Luna (aged 27) works full-time as a marketing and social media manager at a grocery store chain. Having grown up in a rural area located in Oklahoma, she graduated from a small high school along with 71 of her peers. After high school, she earned her Associate's degree in Marketing from a local community college. She and her family still live in Oklahoma and her family are primarily day laborers working various jobs to make ends meet. Luna also has a brother with autism and has an awareness of accessibility challenges.

Winding back to her high school years, although she went to a small high school, she was fortunate to have opportunities to learn computing. Her school offered a basic introduction to computer science (CS) as well as a programming course, and she took both. Her current job requires her to analyze data from social media accounts, create campaigns aligned with her manager's needs and membership wants, and create and modify apps with the AI-Driven Apps (ADA) software tool. When asked how her high school computer science experiences helped her in her career, she reflects that it was critical to her being able to have the confidence to create and modify apps.

While fictional, Luna's experiences illustrate an example of the benefits of early computing education experiences. Though CS education has undergone a rapid evolution over the last decade, what is taught and how it is taught has remained relatively the same. A critical evaluation of CS content knowledge, skills, and dispositions is necessary to ensure CS learning experiences are as relevant for all students as they could be for someone like Luna.

Reflecting on the wide variety of high school student experiences, many factors will likely shape the next decade of secondary (i.e., middle and high school) and postsecondary CS education:

1. The recent K-12 CS movement has led to a population of secondary students interested in CS that are more diverse in demographics and interests and have more CS experience than previous generations of students.
2. There is a growing significance of and need for skills in high-demand topics such as artificial intelligence/machine learning (AI/ML), data science, and cybersecurity.
3. A burgeoning number of secondary students and postsecondary students is interested in minoring/majoring in CS or just taking individual CS courses in college.
4. States are increasingly adopting high school graduation requirements in CS.

The Reimagining CS Pathways project has been initiated to explore how CS learning opportunities can be reenvisioned for high school students. Given the dramatic changes forecasted in computing over the next decade, we engaged in this project using a concerted and community-driven effort to ensure that proper infrastructure and supports are in place to accommodate the evolution of K-12 CS education over the next five to ten years.

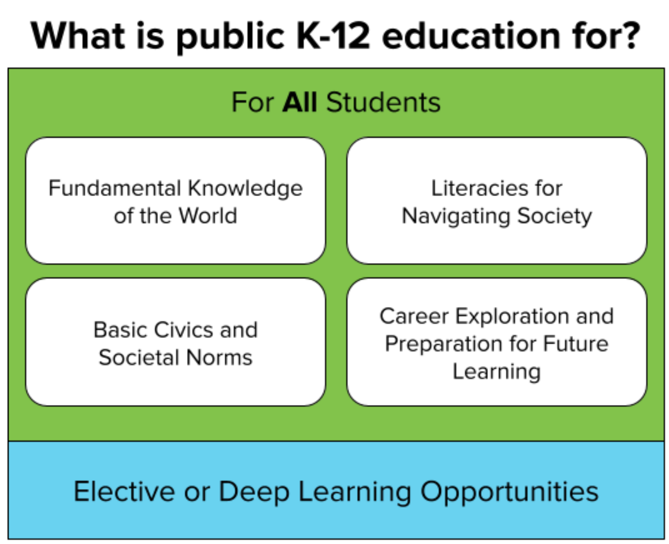
2. Project Background and Overview

The purpose of the Reimagining CS Pathways: High School and Beyond project is to develop community definitions of 1) what CS content is essential for all high school graduates and 2) what content and pathways for continued CS learning should exist for high school students beyond a foundational course. We aim to not only develop recommendations to inform the future of the CSTA K-12 Standards and AP CS courses, but also to clarify the alignment of and develop model pathways for CS learning from high school through introductory computing experiences at the post-secondary level.

Expected outcomes of the Reimagining CS Pathways project include:

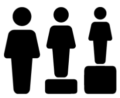
- Three convenings of representatives from across the K-16 CS education landscape (including teachers, administrators, 2- and 4-year college instructors, curriculum developers, and industry), with written summaries shared with the public;
- Release of a written report with recommendations on the content that should be included in experiences/courses satisfying a high school graduation requirement, and how future CSTA standards and AP CS courses might be adjusted to align with such a requirement;
- Models of high school computer science courses (high level course descriptions and outcomes) that create potential pathways beyond an introductory course for all students; and
- A framework that enables a systematic and deliberate process for examining and recreating similar pathways in the future.

Feedback to inform recommendations and next steps are being gathered from a diverse cross section of the CS education community and includes both synchronous and asynchronous opportunities for interactive feedback.

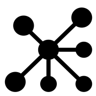


Beyond the project team, this project also has a steering committee to provide additional guidance and to serve as thought partners. During the first convening, one of our steering committee members shared a framework for thinking about what content is essential. As the figure to the right shows, we can divide aspects of education into two types: that which is for all students and that which includes elective or deep learning opportunities. This project builds on this framework by seeking to define what computing content is part of (1) fundamental knowledge of the world, (2) literacies for navigating society, (3) basic civics and societal norms, and (4) career exploration and preparation for future learning. Because the project's goal is to define essential content for all students, it is *not* focused solely on preparation for careers in computing such as software development.

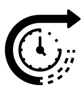
In support of the aims of this project, the following project values have been identified and will be leveraged for continuous reflection on progress and refinement of deliverables.



Equity-centered. Promotes broad and equitable access, participation, and experiences in computer science education among all high school students.



Community-generated. Meets the needs of the community, including K-12 educators, post-secondary institutions, students, parents, and industry.



Future-oriented. Anticipates future needs of current high school learners, and prepares them for a future that is increasingly reliant on computing.

Grounded in research. Reflects the evolving body of knowledge of how students learn computer science.

Flexible in implementation. Considers multiple pathways for meeting individual needs of learners, including regional, cultural, ability, social, and economic factors.

2.1 The Current CSTA Standards

The [CSTA K-12 Computer Science Standards] delineate a core set of learning objectives designed to provide the foundation for a complete computer science curriculum and its implementation at the K-12 level.

The standards, last published in 2017, were designed by educators to be coherent and comprehensible to teachers, administrators, and policymakers in order to:

- Introduce the fundamental concepts of computer science to all students, beginning at the elementary school level,
- Present secondary school computer science in a way that can fulfill a computer science, math, or science graduation credit,
- Encourage schools to offer additional secondary-level computer science courses that will allow interested students to study facets of computer science in more depth and prepare them for entry into college or the workforce, and

- Increase the availability of rigorous computer science course offerings for all students, especially those who are members of underrepresented groups.

The CSTA K-12 Standards are based on the concepts (i.e., knowledge, or what to know) and practices (i.e., skills, or what to do, combined with some dispositions) outlined in the K-12 CS Framework (2016). The standards were written by combining concept statements from the framework with associated practices. The concepts and practices found within the K-12 CS Framework and the CSTA K-12 Standards are:

Concepts

- Computing Systems
- Networks and the Internet
- Data and Analysis
- Algorithms and Programming
- Impacts of Computing

Practices

- Fostering an Inclusive Computing Culture
- Collaborating around Computing
- Recognizing and Defining Computational Problems
- Developing and Using Abstractions
- Creating Computational Artifacts
- Testing and Refining Computational Artifacts
- Communicating about Computing

2.2 Community-Driven Approach

2.2.1 Focus Groups, Interviews, Asynchronous Feedback

In addition to in-person convenings (described below), we also solicited feedback from focus groups, interviews, and asynchronous reviews. Nearly 300 people expressed interest in joining the project in a call for participation distributed in fall 2023.

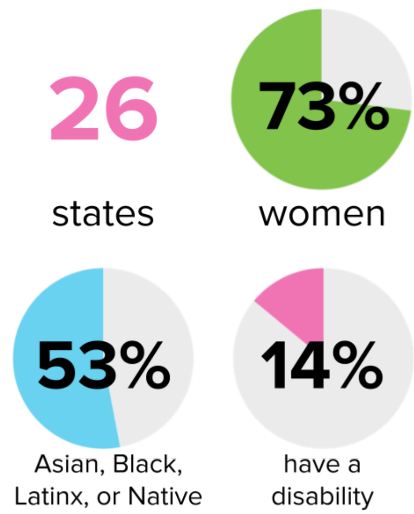
We hosted three focus groups, each meeting three times. Focus groups were organized by role, with one group each for high school CS teachers, higher education CS instructors, and industry representatives. While some of the focus group topics varied according to the expertise of the participants, we sought to get their feedback on what CS content should be prioritized in a foundational high school CS course that may constitute a graduation requirement (which we will call “essential content” in this report), what changes are anticipated in the computing industry in the coming years, what changes are anticipated in higher education CS courses, and what pathways might exist for high school CS.

We conducted one additional interview with a higher education faculty member who was unable to attend the focus group. Additionally, we plan on conducting interviews with several young adults who will be invited to reflect on their experiences with learning CS in high school and/or in postsecondary.

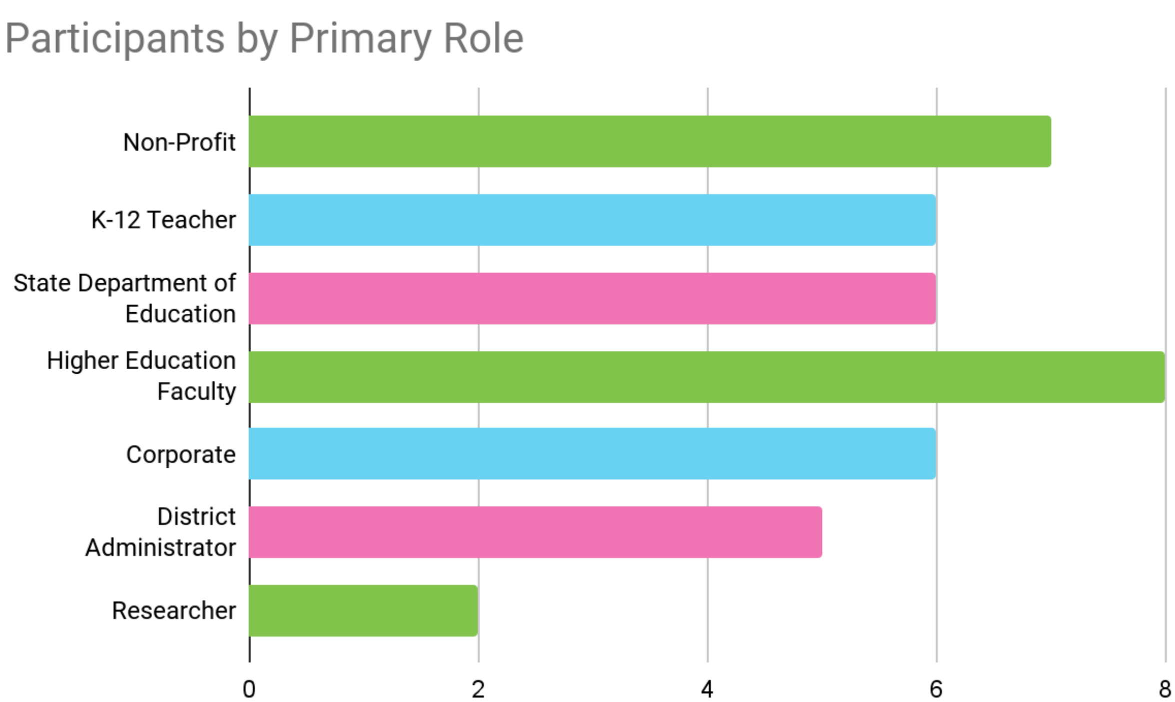
We have also solicited asynchronous feedback – and will continue to do so – from others interested in this work. So far, we have invited these participants to vote and comment on what they believe is essential content; over 135 people participated. We also asked asynchronous reviewers to provide feedback on early drafts of this report; over 25 people participated. Additional sources of input include interactive conference sessions at events such as CSEdCon.

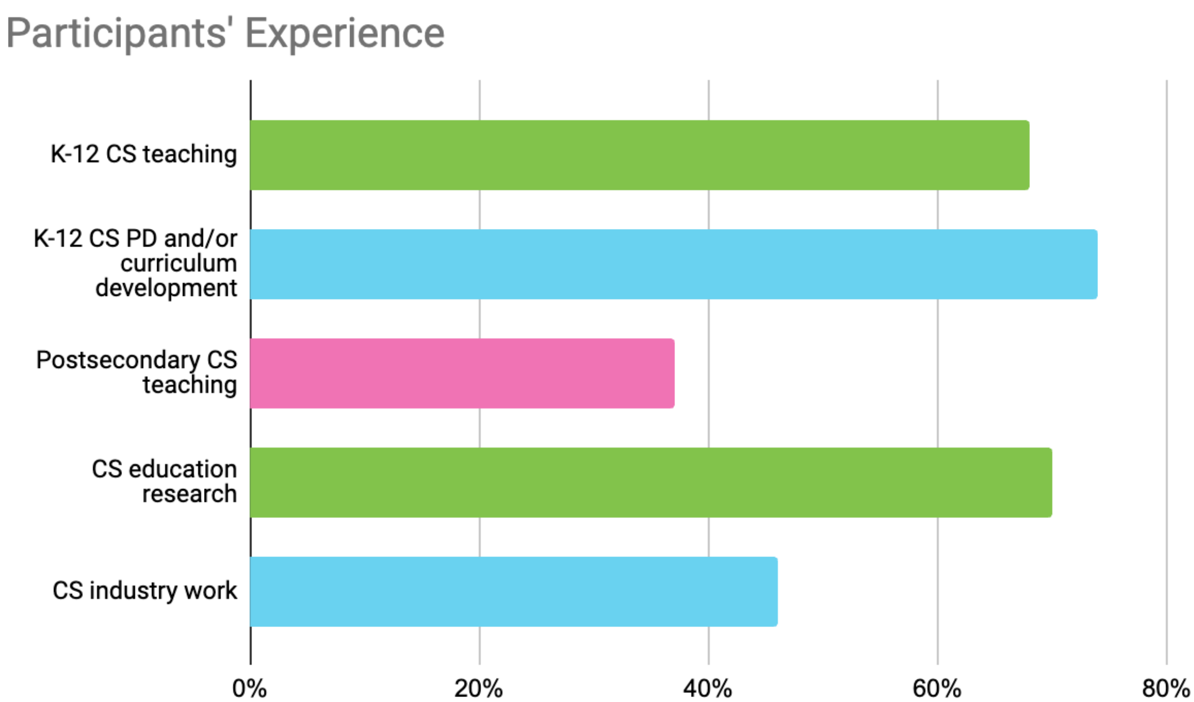
2.2.2 Convening Participants

The steering committee and project team selected 40 convening participants from 26 states, via a process that prioritized deep experience and diversity across a variety of factors, including geographic (i.e., U.S. region as well as urban/suburban/rural), expertise, role, demographic, and institution type. For instance, 73% of selected participants identify as women; 53% identify as Asian, Black, Latinx, and/or Native; and 14% have a disability or chronic condition. Additionally, a breakdown of convening participants by primary professional role and relevant experience can be found below. More detailed demographics are presented in Appendix B.



Thirty-two participants (see list on p. Ⅱ) joined Convening #1. This report summarizes data from these 32 participants, plus five members of the steering committee who were present.





2.3 The First Convening

The Reimagining CS Pathways project has plans to host three convenings (November 2023, January 2024, and March 2024) to explore two primary questions:

1. What CS content is essential for all high school graduates?
2. What pathways for continued CS learning should exist beyond essential content?

Convening #1 took place on November 13-14, 2023, in Chicago, Illinois. In an effort to answer the question and subquestions, a variety of activities were designed to gain participant input concerning key CS content for all high school students, as well as the level of priority associated with that content (see the agenda in Appendix A). On the first day, ideas were generated using the lens of 12 personas, considering what CS knowledge, skills, and dispositions those students would need to experience/develop in high school to be successful in their life and career in the year 2037 (see Appendix C: 12 Personas). Day two of the convening centered around refining and prioritizing the ideas generated on day one. This included identifying gaps and necessary refinements, prioritizing content within categories defined by the concepts and practices from the K-12 CS Framework, and proposing how instructional time might ideally be distributed across these high-level categorizations. A portion of day two was also dedicated to the exploration of dispositions. Throughout both convening days, data was collected via artifact creation (e.g., posters, sticky notes, dot voting) and an online, interactive polling platform (e.g., regular temperature checks, ranking questions, word clouds).

3. Challenges

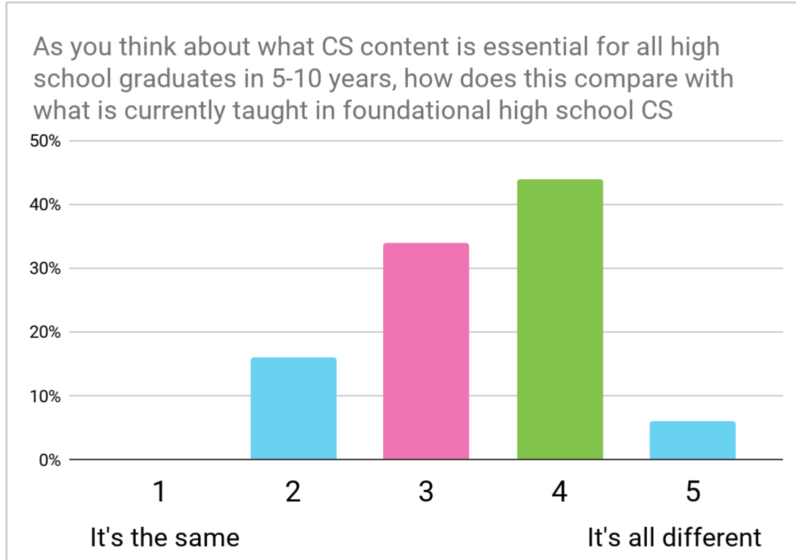
As we reflect on the first convening, one of the major challenges we encountered was the difficulty of anticipating what computing would look like in 5-10 years and what the needs may be for students (both in life and career) who graduate from high school in 2033. As the education sector is still working to understand how to grapple with recent advancements in computing (e.g., use of generative AI in education), there was apprehension among participants around how to predict what changes might be on the horizon and how education should adjust accordingly.

While participants in the first convening were encouraged to organize their recommended content according to CSTA's concepts and practices, we found that this organization led both to duplication and to gaps for the content that participants prioritized. We ultimately found that starting with the categories for content and practices used in the CSTA standards but then iteratively adjusting those categories based on participant suggestions seemed to be the most effective approach because it allowed us to incorporate those suggestions in a way that minimized both overlaps as well as gaps in the categories. That process – and its results – are described below.

Other challenges faced during the analysis of convening one include:

- Many in CS education feel that the introductory college-level CS course (often called CS 1) needs fundamental reconsideration, making it difficult to determine whether essential content should anticipate that reconsideration or prepare students for CS1's current implementation. There was also a perceived disconnect between what is taught in introductory college CS courses and the needs expressed by industry.

- There was a tension between the desire for continuity with current standards and the desire to modify the essential content extensively. The graphic to the right shows the distribution of participants' perception of the comparison between what is currently taught in foundational high school CS courses and what will be essential in 5-10 years.

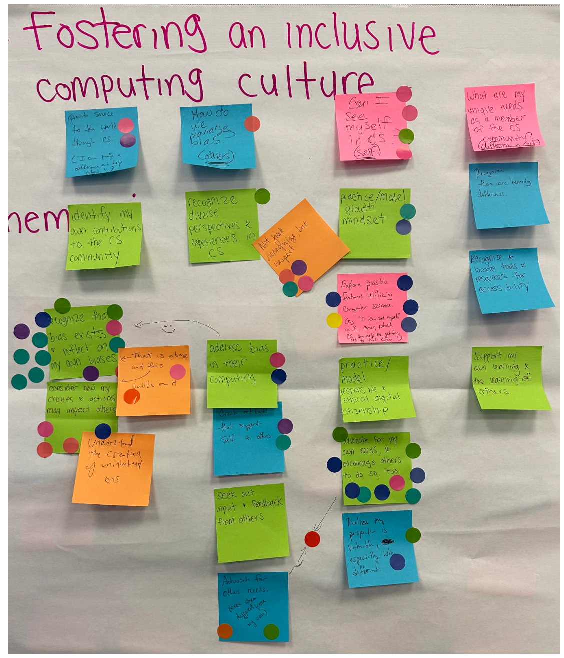


- Questions arose as to what, if any, competencies should be assumed for high school students entering a foundational course. For example, is it reasonable to expect students to understand the basic components of a computer or to have had experience programming using a block-based language?
- Several participants mentioned that it was difficult to forecast what the computing landscape – including emerging technologies and industry needs – would be like in ten or twenty years and, thus, difficult to foresee what knowledge and skills students would need in the future.
- Defining the boundaries of CS was at times challenging. For example, to what extent should digital literacy and digital citizenship be included in essential content?
- Participants recognized that resources are limited, including instructional time and potentially costly materials (such as robotics) and curriculum.

After the convening, the major challenge that the project leadership encountered transforming participant feedback into a set of recommendations was how to organize the feedback in a coherent way. With over 200 suggestions for essential content, it was difficult to synthesize these recommendations into a reasonable number of topics, with a logical organization, and at an appropriate level of granularity. For example, our goal was not to create new standards with this project, but provide direction for those who create new standards in the future.

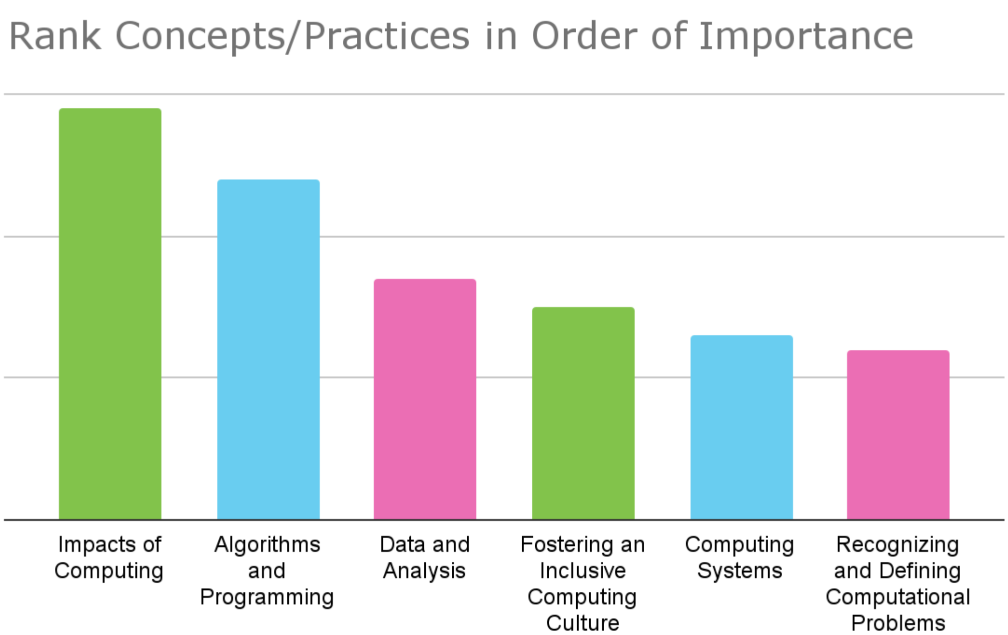
Further, some suggestions (such as the need for students to develop the ability to communicate about CS) could be viewed as either a distinct Topic Area or what we refer to as a Crosscutting Concept, and therefore applied across all other topics. We also explored whether content should be divided (e.g., into knowledge, skills, and dispositions; into concepts and practices). Finally, we struggled with how to frame the findings (including the length of this document) and how to blend research that speaks to how the field of computer science will be changing over the next ten years with the participant feedback.

4. Priorities

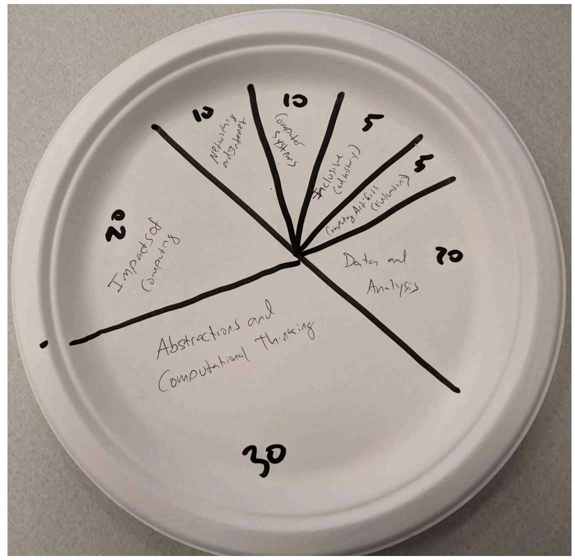


Participants shared priorities for essential CS content in several ways. At more granular levels, participants indicated priority for specific content through multiple rounds of dotstorming (i.e., placing an allotment of sticky dots on the topics they believe are the most important for all students). First, participants placed up to ten sticky dots across all content. Later, after refining content, participants voted within each concept/practice by placing zero to two sticky dots on specific content within each topic. High concentrations of these dots led to the prioritized content statements bolded in the recommendations presented in Section 6. The photo on the right shows an example of dotstorming in action, with high priorities placed on recognizing biases and reflecting on one's own biases and advocating for the needs of self and others.

Higher level priorities were determined in three main ways. First, we identified topics with higher concentrations of prioritized granular content (i.e., more dot voting within the topic). Second, participants rank-ordered their top five priorities aligned to the concepts and practices from the CSTA K-12 Standards and K-12 CS Framework, plus a few other topics (e.g., AI, data science). See figure below with participants' ranked priorities.



Third, participants worked collaboratively to assemble a full, complete, and balanced, but not overflowing, plate to represent essential CS content for all high school students by writing topics on a paper plate in proportional size to their importance. See the photo to the right with one example plate indicating priorities for computational thinking, impacts of computing, and data & analysis.



Trends indicating high-level priorities across these various methods and their impact on the recommendations are explained below.

4.1 Impacts and Ethics

Participants repeatedly flagged social impacts of computing and related ethical implications as being of critical importance in the essential content. In fact, it was the highest rated discrete topic, and it was commonly integrated across other Topic Areas, thus making it a suggested Crosscutting Concept. To reflect this prioritization, we included content related to societal impacts and ethical issues within each Topic Area. This content includes but is not limited to instruction related to social justice, equity, and, more generally, ensuring that computing benefits all members of society, especially the most vulnerable. We expect a foundational course to spend a substantial amount of time on these issues, and to do so in a way that integrates these ideas with more technical topics so that students understand the interwoven relationships between technical considerations (e.g., how data is represented in a system) and societal and ethical implications (e.g., whether a user can enter data into a form in a way that respects their identity, such as the use of characters not found in English, preferred way of describing their gender, etc.).

4.2 Algorithms and Programming

Algorithms and programming were highly prioritized, similar to the significant priority placed in current curricula and high school instruction. However, a marked difference is a greater emphasis on algorithms and computational thinking and lesser emphasis on programming as it is taught today. Given the capabilities of generative AI systems, participants discussed the continued need for students to learn programming but balanced with skills in reading, modifying, and debugging code. Participants also highlighted the ongoing importance of “the basics” in order to fully understand and leverage technological advancements. They acknowledged that the ways in which students program would change (e.g., using AI-generated code as a starting point, greater use of embedded systems with non-code programming interfaces), though basic principles and content would still be vital. To reflect this prioritization, we defined two Topic Areas: (1) Algorithms and (2) Programming and one Crosscutting Concept: Computational Thinking.

4.3 Data and Analysis

Data and Analysis was consistently one of the highest priorities among convening participants. This is likely due to the increased prevalence of data in daily aspects of life, as well as the vast amount of data upon which emerging AI technologies are built. This trend also acknowledges data science as a burgeoning and increasingly important field with strong foundations in CS. We defined Data and Analysis as one of five Topic Areas to reflect this prioritization.

4.4 Fostering an Inclusive Computing Culture

As previously noted, one of the core values of the Reimagining CS Pathways project is equity-centered. The prioritization of the Fostering an Inclusive Computing Culture practice honors equity as a value. This practice was the highest ranked of all of the practices and received a level of priority in alignment with many of the top rated concepts. Key skills identified within this practice included respecting diverse perspectives and experiences in CS, recognizing and addressing biases, and advocating for the needs of others. Participants indicated the overlapping nature of other important skills related to communication and collaboration within CS. This led us to defining a Crosscutting Concept of Inclusive Collaboration.

4.5 Computing Systems & Security

Two concepts, Computing Systems and Networks and the Internet, were often grouped together when convening participants were indicating priorities across Topic Areas. Interrelated and complementary content within each of these concepts led us to combine them into one Topic Area: Computing Systems and Security. The combination of these two concepts was given a relatively similar level of priority as other standalone, pre-existing concepts.

4.6 Artificial Intelligence

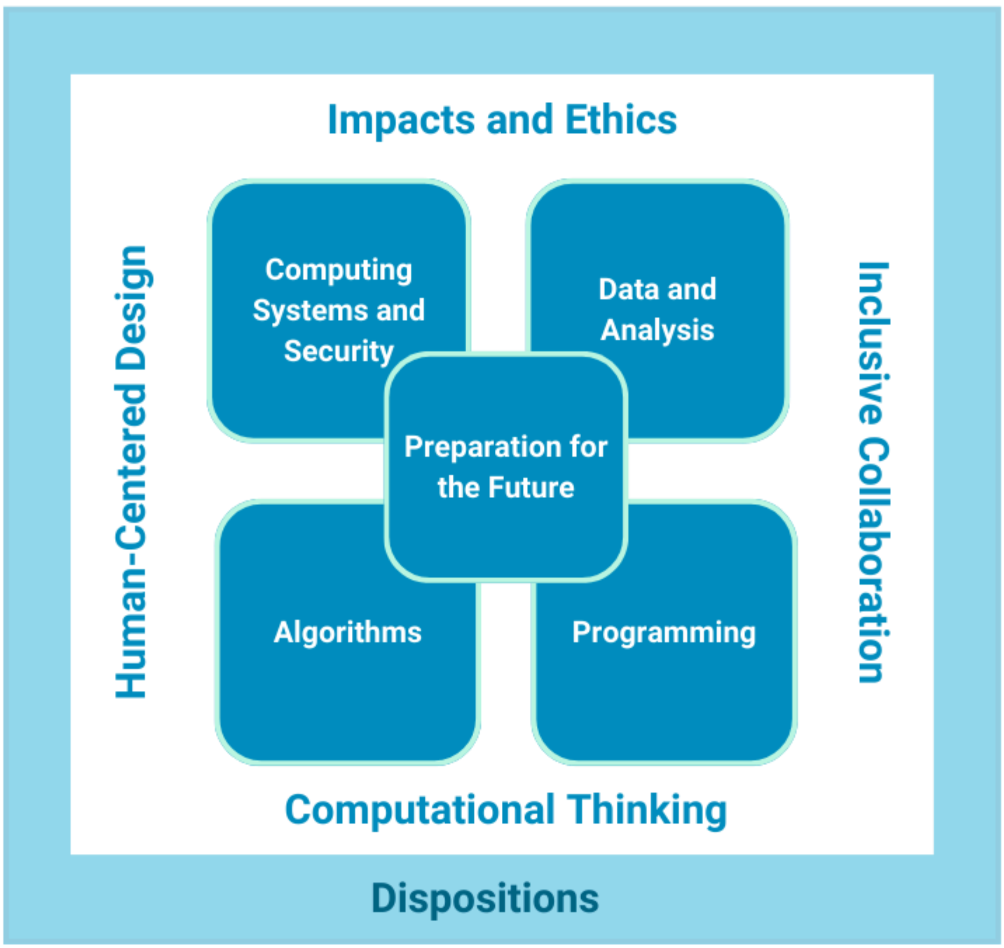
Artificial intelligence (AI) was not prioritized as a discrete topic, but it was frequently included in essential content organized within other Topic Areas. AI content was most prevalently organized within the Algorithms and Programming, Data and Analysis, and Impacts of Computing concepts. Participants also discussed the importance of including emerging technologies, to account for significant advances in the future that cannot be predicted; we included this within a new Topic Area called Preparation for the Future.

4.7 Careers

Knowledge of careers – both those in computing and those involving computing – were frequently identified as part of essential CS content. This was identified as perhaps the most significant gap from current standards and implementation. This priority on career awareness aligns with the idea that all disciplines and career fields are becoming increasingly reliant on or impacted by computing (e.g., AI). Participants prioritized the exploration of diverse career options and pathways, plus building skills and experiences that would prepare them. To reflect this prioritization, we defined a new Topic Area called Preparation for the Future.

5. Structure of the Recommendations

Recommended high-level topics emerged through analysis of convening data and review of relevant research. Note that we combined CSTA's concepts and practices into *Topic Areas*. The result of these changes is five Topic Areas (blue shaded boxes), four Crosscutting Concepts (within the white square), and the inclusion of dispositions (outer blue square) as shown in the figure below:



We cross-mapped those topics to the current organizational structure of the CSTA K-12 standards as illustrated in the table below. We also noted that dispositions are less likely to be covered in standards and in curriculum than in pedagogy and instructional approaches; nevertheless, there is decades of research that shows that dispositions are critically tied to academic achievement and therefore cannot be ignored. They are included here for completeness and to signal their importance when standards are developed in the future.

	CSTA Standards & K-12 Framework	Reimagining CS	Justification for Change
CONCEPTS	Computing Systems	Computing Systems and Security	Combined to reflect the overlap in key content as well as participant priorities
	Networks and the Internet		
	Data and Analysis	Data and Analysis	*No change*
	Algorithms and Programming	Algorithms	Separated to reflect the importance of algorithms and their distinction from programming
		Programming	
	Impacts of Computing	*Impacts and Ethics*	Integrated to reflect the importance of integrating consideration of impacts and included as a Crosscutting Concept
PRACTICES	Recognizing and Defining Computational Problems	*Added to Algorithms*	Added to other areas (as indicated) due to overlap in key content
	Developing and Using Abstractions	*Added to Algorithms*	
	Creating Computational Artifacts	*Added to Programming*	
	Testing and Refining Computational Artifacts	*Added to Programming*	
	Fostering an Inclusive Computing Culture	Inclusive Collaboration	Added as a Crosscutting Concept due to overlap in key content and its relevance to all other areas
	Collaborating around Computing		
	Communicating about Computing		
NEW	*N/A*	Human-Centered Design	Added as a Crosscutting Concept as a result of its importance in the context of accessibility and human-centered computing
		Dispositions	Added as a Crosscutting Concept to reflect the importance of certain dispositions (e.g., persistence)
		Preparation for the Future	Added as a Topic Area to highlight the importance of learning about (1) pathways and careers in computing and (2) emerging technologies
		Computational Thinking	Added as a Crosscutting Concept to reinforce the importance of developing computational thinking skills across Topic Areas

6. Recommendations

6.1 Crosscutting Concepts

We refer to those ideas that must be integrated into each Topic Area as Crosscutting Concepts. These are important concepts and cannot be ignored – in effect, they are captured in this framework, but how they might be incorporated is not addressed within this report.

6.1.1 Impacts and Ethics

As computing becomes ever more pervasive, its social and ethical implications also become more important. Thus, it is crucial that students' understanding of these implications grows alongside their understanding of more technical concepts, and this area was consistently highlighted by convening participants as the most important content. Impacts and Ethics is a Crosscutting Concept, and additional elements of computing impacts and ethics are also found within the content of each Topic Area. Discussion of impacts and ethics includes but is not limited to:

- Societal impacts of computing
- Ethical issues in computing
- Social justice issues
- Access and equity concerns
- Ensuring that computing benefits all members of society, especially the most vulnerable
- Safety and privacy

6.1.2 Inclusive Collaboration

The core of Inclusive Collaboration is, as one participant phrased it, to *engage with diverse perspectives with respect and empathy.* Specifically, participants prioritized the following aspects of inclusive collaboration:

- Awareness and Empathy with Others
    - Accommodate a variety of identities and perspectives, including from those with disabilities and/or from different cultural backgrounds.
    - Recognize and mitigate personal biases.
    - Provide service to other people and groups via computing.
    - Support the learning of others.
    - Design and develop with accessibility in mind.
- Collaboration Skills
    - Recognize different roles on a team, and be able to assume different roles.
    - Seek out and use feedback from others.
    - Provide others with constructive feedback.
    - Advocate for the needs of others.

    - Use appropriate tools, including digital tools, for collaboration.
    - Use a variety of models and methods for collaboration, including pair programming.
    - Be able to communicate about technology in a variety of contexts (using precise, domain-specific vocabulary) and with those with limited technical knowledge (translating technical concepts into common language).
    - Be able to document products and processes.
    - Apply principles of digital citizenship including data security, responsible communication, information evaluation, and respect for intellectual property (*note that this content was a high priority for participants).*

It is important to integrate Inclusive Collaboration into each Topic Area to ensure that students implicitly understand that these principles should be interwoven into all computing endeavors.

6.1.3 Computational Thinking

The K-12 CS Framework (2016) defines computational thinking as "the thought processes involved in expressing solutions as computational steps or algorithms that can be carried out by a computer" (para. 2). Computational thinking includes algorithm development, decomposition, pattern recognition, and abstraction, and "a fundamental skill for everyone, not just for computer scientists" (Wing, 2006). The tenets of computational thinking should underpin instruction in each Topic Area and serve as connective tissue across CS learning experiences.

6.1.4 Human-Centered Design

With no-code and low-code environments expected to evolve rapidly over the next few years, this affords more opportunities to infuse design thinking into high school CS learning opportunities. Human-Centered Design will be critical as programming continues to be automated. Coupled with algorithmic thinking and auditing, humans will be needed to build empathy and understanding into the design, feed the design to the AI "programmer", and audit and refine the results.

Human-Centered Design encompasses aspects of planning that are user-focused. Skills include:

- Understand principles of effective design, including identifying problems and understanding underlying causes.
- Empathize with those impacted by the problems, including designing for accessibility.
- Think of everything (and approach solutions) as a system.
- Generate ideas to solve problems, including considering who is affected by design choices and how they are affected.
- Prototype, test, and iterate.
- Understand how design decisions shape computing.

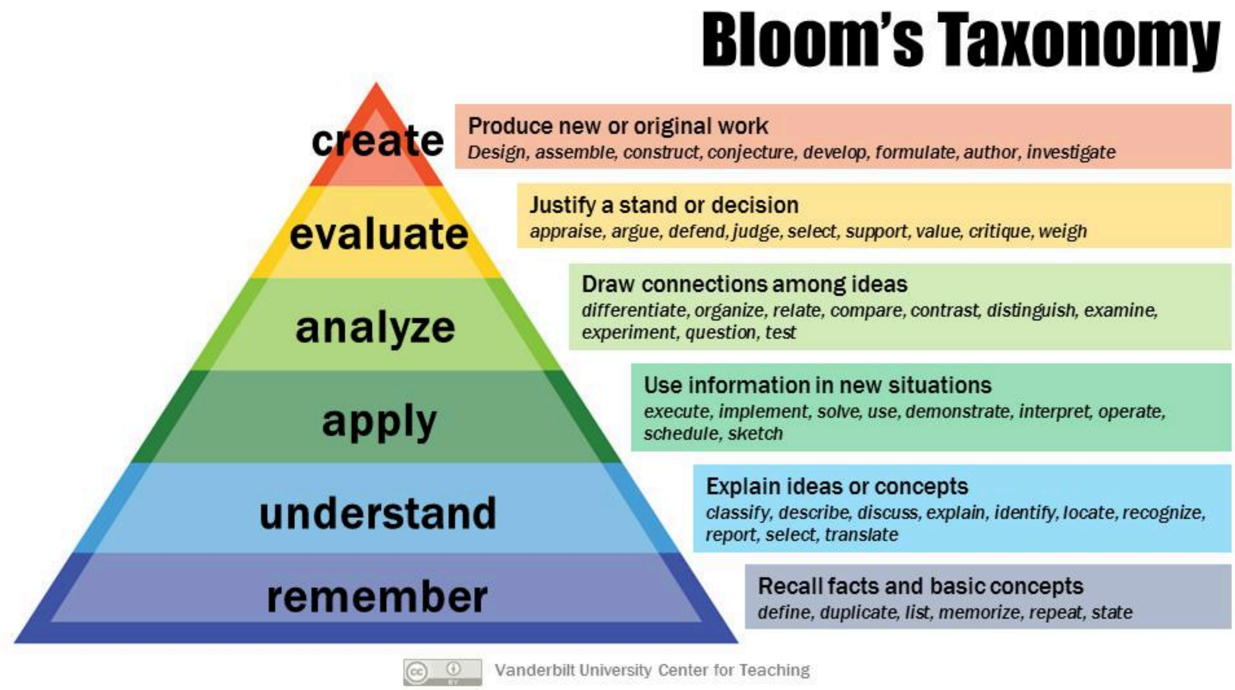
6.2 Dispositions

Dispositions can be understood as personal inclinations that are general and stable. Researchers have identified dispositions that are correlated with learning outcomes (both positive and negative). Based on participants' contributions, we include these prioritized dispositions, with the definitions developed by participants:

- *Persistence*. "Voluntary continuation of a goal-directed action in spite of obstacles, difficulties, or discouragement" (Peterson and Seligman, p. 229).
- *Reflectiveness.* The process of "turning experience into learning" (Boud et al., 2013) through the student thinking about the results of past actions and allowing that prior knowledge to inform predictions of possible outcomes of future actions.
- *Creativity*. "The interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context" (Plucker et al., p. 90).
- *Curiosity*. The desire for new knowledge, information, experiences, or stimulation to resolve gaps or experience the unknown (Arnone and Grabowsky, 1992; Berlyne, 1954; Litman, 2005).
- *Critical thinking.* "The mental processes, strategies, and representations students use to solve problems, make decisions, and learn new concepts" (Sternberg, 1986, p. 3). The student goes beyond lower level thinking (such as memorizing and recalling information) to analyze, interpret, and synthesize information, engaging (Kennedy et al., 1991).
- *A sense of belonging in computing*. "Personal involvement (in a social system) to the extent that the student feels that they are an indispensable and integral part of the system" (Anant, 1967, p. 391).
- *Resourcefulness*. "Self-regulating one's emotional and cognitive responses during stressful situations, using problem-solving skills, and delaying immediate gratification for the sake of more meaningful rewards in the future" (Rosenbaum, 1989, p.249).

6.3 Topic Areas

As described above, we adjusted the concepts and practices found in the current CSTA K-12 Standards to generate five Topic Areas. We then used Bloom's Revised Taxonomy to organize the CS content within each Topic Area (see image below). Bloom's taxonomy was developed to provide a common language for educators to communicate about learning and assessment methods through a framework for each stage of learning. While acknowledging that this taxonomy has limitations, we feel that it is the best available framework for this project. A task force of the ACM's Committee for Computing Education in Community Colleges (CCECC) recently created a report that maps verbs commonly used in computing (e.g., *deploy, model, script*) to Bloom's Revised Taxonomy (Geissler et al, 2023). We leveraged their work as the basis for organizing the computing content within each Topic Area.



While these areas are presented individually, we also recognize that there is overlap and even sequencing between them. Further, specific knowledge and skills that were prioritized by convening participants are shown in bold.

6.3.1 Algorithms

Algorithms are a fundamental part of computer science, and understanding basic principles of algorithms is a necessary foundation for further work in computing. In this Topic Area, students are exposed to high-level concepts related to algorithms.

Remember	Define *algorithm* and explain what algorithms are used for
	Recognize that computational solutions take in information, store and process it, and produce a result
Understand	**Describe the difference between traditional and AI/ML algorithms and, at a high level, describe how AI/ML algorithms work**
	Explain why/how sequence matters in an algorithm
	Describe patterns/commonalities in problems, data, and programs
	Interpret algorithms
Apply	Modify an algorithm (e.g., to add functionality)

	Apply strategies for learning what is inside of an opaque system when it is necessary to do so
Analyze	**Decompose a problem into multiple subproblems**
Evaluate	Evaluate (at a high level) the trade-offs (e.g., speed) of different algorithms
	Evaluate the appropriateness, reasonableness, and/or effectiveness of an algorithm for a specific task, including via algorithmic auditing
	Assess societal impacts of the application of computational thinking and related ethical issues (e.g., use of AI algorithms to choose job candidates, use of abstraction to obscure important context)
Create	Compose algorithms using sequence, selection, and iteration
	Create a variety of abstractions and models to represent a system

6.3.2 Programming

As mentioned above, ‘programming’ is construed broadly to describe a variety of ways of generating computational artifacts. Programming, in the context of essential content for high school, is likely to include block-based and/or text-based programming languages. It may also include other computational artifacts, such as simulations, visualizations, robotic systems, or digital animations.

Remember	Locate common programming constructs (e.g., using online tools)
Understand	Convert an algorithm to code
Apply	Apply programming skills in text-based and non-text-based programming contexts (e.g., block-based, kiosk, prompt engineering)
	Modify a program (e.g., add functionality or improve usability or accessibility)
	Use programming assistive technologies (e.g., Copilot) to plan, write, test, and debug code
Analyze	Articulate whether a program solves a given problem
Evaluate	**Systematically test and debug a program, including the use of skills such as code tracing**
	Evaluate whether and how computation can or cannot help to solve a problem
	Assess societal impacts of programming and related ethical issues (e.g., how might modifications to a program impact various groups of users?)
Create	**Develop programs using sequencing, selection, and iteration**

6.3.3 Data and Analysis

The increasing importance of data science and artificial intelligence (AI) / machine learning (ML) points to the importance of understanding the basic elements of data and its analysis.

Remember	**Identify and define data types (e.g., string, numeric, Boolean)**
	Identify basic data formats (e.g., tables, schemas, JSON)
Understand	Describe, at a high level, the role of data in AI/ML applications
	Understand the difference between data and metadata
Apply	Manipulate (e.g., normalize, transform, clean) data
Analyze	Trace how data moves through a program
Evaluate	Evaluate approaches to cleaning data in a given context
	Assess whether and how a given question can be answered with data, and what specific data is needed
	Assess societal impacts of data analysis and related ethical issues (e.g., biased data used to train AI systems, attribution related to products of generative AI)
	Evaluate data visualizations for clarity, potential biases, etc.
Create	**Select, organize, interpret, and visualize large data sets from multiple sources to support a claim and/or communicate information**
	Devise plans for using data to solve a problem

6.3.4 Computing Systems and Security

Computing Systems and Security combines two concepts from the CSTA standards: Computing Systems and Networks and the Internet. This area includes the broad categories of devices, hardware, software, troubleshooting, networks, and cybersecurity.

Remember	Identify various types of hardware (including components) and software (including operating systems)
	Enumerate security practices (e.g., safe passwords, two-factor authentication)
Understand	Describe why cybersecurity is important
	Explain what networks (including the Internet) are and how they work
	Explain how an operating system, other software, and hardware work together

Apply	Manipulate operating systems and other software settings to achieve goals
	Apply knowledge of the structure and function of various technologies (e.g., cloud computing, sensors, GPS, embedded/IoT, phones/tablets, gaming consoles, medical devices, VR, robotics) to optimize their use (for example: explain why GPS can be used without Internet access)
	Use documentation and other resources to guide tasks such as installation and troubleshooting
Analyze	Detect vulnerabilities in networks
	Analyze a problem to determine appropriate troubleshooting strategies
Evaluate	Assess societal impacts of networks and related ethical issues (e.g., digital divide)
Create	Design projects that combine hardware and software that collect and exchange data

6.3.5 Preparing for The Future

This Topic Area brings together two threads: 1) the student's own future, specifically pathways and careers that involve computing in some respect and 2) emerging technologies, including their societal implications and ethical issues.

Remember	**Identify pathways and careers that involve computing**
Understand	Explain how computing enables emerging technologies such as autonomous vehicles and how these emerging technologies are applied in various industries
Apply	Apply computing concepts to other disciplines
Analyze	Examine how emerging technologies are impacting a variety of practices (e.g., use of facial recognition in policing, AI-generated news products)
Evaluate	Assess societal impacts and related ethical issues of emerging and future developments in computing (e.g., the impact of quantum computing on security)
	Evaluate the use of emerging technologies (e.g., generative AI) for accuracy (e.g., detect hallucinations) and to meet specific needs
Create	Plan how an emerging technology could meet a need
	®

7. Conclusion and Ongoing Considerations

While Luna pursued her on-the-job training needs with the help of her employer, she retrospectively thought that her experience learning CS in high school offered her some of the knowledge and skills she needs in her current job that make her more successful in her role. One of the goals of this project is to recommend essential CS content for all students to inform the next iteration of K-12 CS education (e.g., what CS content should be taught in high school).

One participant noted the implicit assumption that students who do not show mastery of the proposed content, which may be used to inform a graduation requirement, may therefore not be able to graduate from high school. This places a substantial burden on the project to justify its recommended content. It is our hope that this interim report presents an adequate justification of both the process and the result of this project's work to define the essential CS content for all high school graduates.

As we continue to navigate this project, the following represent challenges that have not been resolved and remain considerations in future work:

- Can we rely on the recommendations to be something that we build over time (across K-12) or does it have to be something a CS teacher can cover the entirety of within a high school course (i.e., one or two semesters)?
- How do we balance breadth versus depth? If we try to include everything, we risk sacrificing depth.
- Is there a difference between what the CS education community and industry want students to learn/know and what students want and need to learn/know?
- How do we account for the future when we don't know what it will entail?
- How should the availability of CS teachers (or lack thereof) inform this project?

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9. Appendices

Appendix A: Convening #1 Agenda

Reimagining CS Pathways: High School and Beyond

First Convening

November 13 - 14, 2023

Chicago, IL, USA

Convening Goal

- **Define what CS content is essential for all high school graduates.**

Sunday, November 12, 2023

- Travel to Chicago

Monday, November 13, 2023

- 8:00 - 8:30 am — Breakfast
- 8:30 - 9:30 am — Project Overview, Networking, Norms
- 9:30 - 10:45 am — Visioning and Thinking Toward the Future
- 10:45 am - 12:30 pm — Identifying Essential CS Content
- 12:30 - 1:30 pm — Lunch
- 1:30 - 4:00 pm — Continue Identifying Essential Content
- 4:00 - 4:45 pm — Teacher Panel
- 4:45 - 5:00 pm — Wrap-up
- 6:30 - 8:30 pm — Working Dinner

Tuesday, November 14, 2023

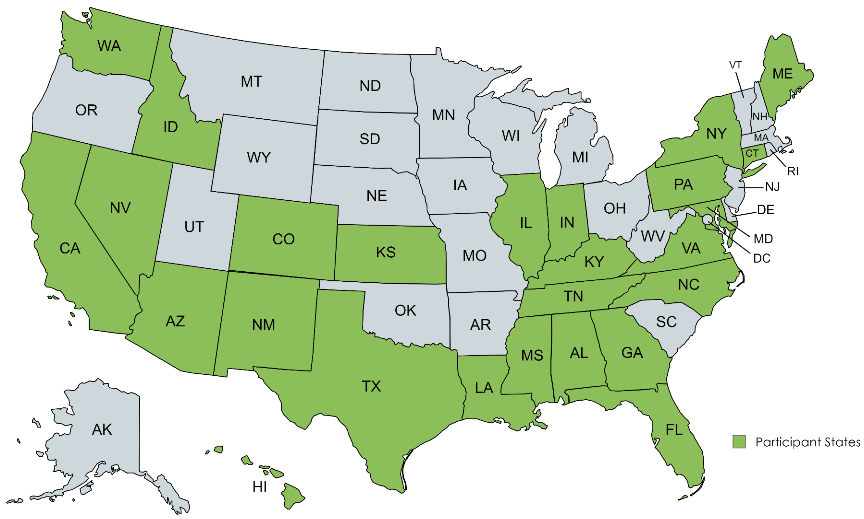
- 8:00 - 8:30 am — Breakfast
- 8:30 - 9:00 am — Overview of Day 2 and Networking
- 9:00 - 11:45 am — Refine and Prioritize Essential CS Content
- 11:45 am - 12:45 pm — Lunch
- 12:45 - 1:45 pm — Continue to Refine and Prioritize
- 1:45 - 2:00 pm — Debrief and Close-out

Appendix B: Participant Demographics & Experience

The steering committee and project team selected 40 convening participants via a process that prioritized deep experience and diversity across a variety of factors, including geographic (i.e., U.S. region as well as urban/suburban/rural), expertise, role, demographic, and institution type).

States

Participants represent 26 states: AL, AZ, CA, CO, CT, FL, GA, HI, ID, IL, IN, KS, KY, LA, MD, ME, MS, NC, NM, NV, NY, PA, TN, TX, VA, and WA.



Created with mapchart.net

Race/Ethnicity

The table below shows the distribution of participants' racial and ethnic identities. Several participants identify with multiple races or ethnicities, so the numbers and percentages do not sum to 40 and 100%, respectively.

Race/Ethnicity	Number	Percent
White or Caucasian	21	53%
Black or African American	8	20%
Hispanic or Latinx	7	18%
Asian or Asian American	5	13%
Prefer not to answer	2	5%
American Indian or Alaska Native	1	3%
Native Hawaiian or Pacific Islander	0	0%
Another race or ethnicity	0	0%

Gender Identity

The majority of participants identify as women (*n* = 29, 72.5%), and the remainder identify as men (*n* = 11, 27.5%). No participants identify as non-binary or another gender.

Gender Identity	Number	Percent
Woman	29	73%
Man	11	28%
Non-Binary	0	0%
Another gender	0	0%
Prefer not to answer	0	0%

Disability Status

Approximately 14% of participants identify as having a disability or chronic condition. We did not collect data about specific types of disability or condition, though we did ask about and provide disability-related accommodations at convenings.

Identify as having a disability	Number	Percent
No	27	75%
Yes	5	14%
Prefer not to answer	4	11%

Primary Professional Role

Participants' current and primary professional roles were relatively balanced across K-12 teachers, higher education faculty, district administrators, state departments of education, corporations, and K-12 CS education non-profit organizations. While there are only two participants whose primary role is researcher, 70% of participants have experience with CS education research (as shown in the next table: Professional Experience).

Primary Professional Role	Number	Percent
Higher Education Faculty	8	20%
Non-Profit	7	18%
Corporate	6	15%
K-12 Teacher	6	15%
State Department of Education	6	15%
District Administrator	5	13%
Researcher	2	5%

Professional Experience

Participants have wide-ranging experience across K-12 CS education, postsecondary CS education, and industry, with an average of 9 experience types listed in the table below.

Experience	Number	Percent
K-12 CS professional development	28	76%
CS education research	26	70%
K-12 CS curriculum development	23	62%
9-12 CS teaching	21	57%
Teaching introductory high school CS courses	20	54%
K-12 CS standards development	17	46%
CS industry work	17	46%
Teaching AP CS Principles and/or AP CS A courses	16	43%
6-8 CS teaching	14	38%
K-12 school leadership	12	32%
K-12 district or local education agency leadership	12	32%
K-5 CS teaching	9	24%
K-12 state education agency leadership	9	24%
Postsecondary CS teaching at 4-year primarily undergraduate institution	8	22%
Postsecondary CS teaching at 4-year PhD-granting institution	8	22%
Teaching dual enrollment CS courses	5	14%
Postsecondary CS teaching at HSI	4	11%
Postsecondary CS teaching at 2-year institution	3	8%
Postsecondary CS teaching at HBCU	1	3%
K-12 guidance counselor	0	0%
Postsecondary CS teaching at Tribal College/University	0	0%

Expertise Supporting Marginalized Groups

Participants have significant expertise serving student populations that are marginalized and underrepresented in CS education, as indicated in the following table.

Expertise Supporting Marginalized Groups	Number	Percent
Girls and non-binary students	28	76%
Economically disadvantaged students (or Title I schools)	22	59%
Latinx or Hispanic students	22	59%
Black or African American students	19	51%

Expertise Supporting Marginalized Groups	Number	Percent
Students with disabilities	19	51%
Bi-/multi-lingual learners (English learners)	16	43%
Rural communities	15	41%
Native or Indigenous students	9	24%
Students who identify as LGTBQ+	8	22%
Students who are experiencing homelessness	7	19%
Migrant students	7	19%

CS Content Teaching Experience

Participants have taught the following CS content in their classrooms. The most common topics were computational thinking, algorithms, programming, and impacts of computing.

CS Content Coverage	Number	Percent
Computational thinking	26	70%
Algorithms and programming	25	68%
Impacts of computing	24	65%
Digital citizenship	23	62%
Computing systems (e.g., hardware/software)	21	57%
Data and analysis	21	57%
Networks and the Internet	21	57%
Ethics	20	54%
Accessibility	19	51%
Web development	19	51%
Physical computing	18	49%
App development	15	41%
Artificial intelligence (AI)	15	41%
Cybersecurity	15	41%
Robotics	14	38%
Data science	13	35%
Game design / development	13	35%
Internet of things	13	35%
Quantum computing	3	8%

Appendix C: 12 Personas

Ahmed Ali

Software Developer

Reimagining CS Pathways
High School and Beyond

CURRENT JOB
Ahmed is a software developer for a large home improvement chain store.

LOCATION
Oakwood Park, Illinois (near Chicago)

EDUCATION
- M.S. in Computer Science
- Software Developer Internship at Home Improvement Chain Store
- B.S. in Computer Science
- Graduated from Chicago STEM Magnet High School (urban school, graduating class of 963 students)

ASPIRATIONS
His current assignment is to work through a backlog of bug fixes and updates to the portion of the company's app that customers use to plan their home improvement projects.
During his internship, he overheard several discussions about the potential for a breach of customer data.

BACKGROUND
Ahmed was raised in Chicago in a middle-class family to immigrant parents from Syria. Ahmed came to the U.S. as a refugee when he was 9 years old and knew no English.

PERSONAL
Ahmed is acclimating to the shift from graduate student to employee and exploring several possible personal interests and hobbies. He often writes poetry in his spare time.

Amit Khan

Data Analyst

Reimagining CS Pathways
High School and Beyond

CURRENT JOB
Amit recently accepted a position in Silver Spring, Maryland, with the National Oceanic and Atmospheric Administration as a data analyst.

LOCATION
Silver Spring, MD

EDUCATION
- B.S. in Data Science from University of California Los Angeles
- Graduated from Nashville West High School (urban school, graduating class of 1,425 students)

ASPIRATIONS
Amit struggles still with the lack of tools available so that he can excel at his job. He looks forward to new technologies that provide more assistance.

BACKGROUND
Amit was raised in Nashville, Tennessee, by a mother who worked part-time in a library and a step-father who managed the databases for a local group of banks.

Amit has had a vision impairment since birth, which meant that some activities – both in school and outside of school – were inaccessible to him. His mother was a forceful advocate for him and encouraged him to attend college.

PERSONAL
In his free time, Amit enjoys lifting weights, creating pottery, and listening to audiobooks.

Ava Thompson

Licensed Therapist

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High School and Beyond

CURRENT JOB

Ava is a licensed therapist in New York City for both in-patient and patients located remotely. She specializes in addictions (i.e., gambling, games, social media).

LOCATION

New York City, New York

EDUCATION

- B.A. in Social Work from Winston College
- Graduated from Brooklyn Woodruff High School (urban school, graduating class of 2,228 students)

ASPIRATIONS

One of the main challenges of her work is managing the care of patients who are not fluent in English (Ava does know a bit of Korean, but not well enough to provide care). She seeks creative and meaningful ways to communicate and connect with her patients.

BACKGROUND

Ava was raised in Brooklyn by parents of Korean and Chinese heritage in a middle-class household.

Life in the city gave her exposure to multiple cultures and a wide variety of activities, including music, dance, and art.

PERSONAL

Ava enjoys listening to music and watching improv with her friends. She also serves as an election worker each election day and volunteers at the local Animal Humane Society.

Benja Smith

Assistant Manager, Grocery Store

Reimagining CS Pathways
High School and Beyond

CURRENT JOB

Benja is an assistant manager at a grocery store.

LOCATION

Toledo, Ohio

EDUCATION

Graduated from Banyon High School (urban school, graduating class of 1,263 students)

ASPIRATIONS

He frequently uses open-source software in his audio work and would like to continue to do this for fun. However, he is concerned about the ability of musicians to protect their intellectual property, especially in the face of new AI tools.

BACKGROUND

Benja was raised by a single mother in Toledo, Ohio. He enjoyed school but had no interest in attending college due to the high costs and the pressure to keep up with studies and homework, which he often felt were irrelevant to him in high school.

PERSONAL

He is in a band, and he also does some freelance work for local bands as an audio technician. He spends his free time listening to music, attending concerts, and rock climbing.

Bishakha Meremikwu

Medical School Student

CURRENT JOB

Bishakha is a third-year medical student.

LOCATION

Chicago, IL

EDUCATION

- B.A. in Physics
- Graduated from Wauswego High School (urban school, graduating class of 832 students)

BACKGROUND

Bishakha was born in Lagos, Nigeria, and moved to Milwaukee, Wisconsin, with her parents, who are both doctors, when she was in the sixth grade.

PERSONAL

While she does not have much free time, she enjoys yoga and watching cooking shows.

ASPIRATIONS

She has not yet decided on a medical speciality; she is considering family medicine, but she is also contemplating medical research.

Bishakha has observed that the treatment plans presented to her family and friends when they receive medical care differ greatly from the guidelines that she is learning in her coursework. She wonders how much of this is driven by software that recommends treatment, by insurance companies trying to cut costs, by the fact that most of her family and friends are Black, or by some combination of these factors.

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High School and Beyond

Blake Huston

Tradesperson

CURRENT JOB

Blake makes a living doing household repairs, carpentry, and small engine repairs.

LOCATION

Chippaqua, Oklahoma

EDUCATION

Graduated from Chippaqua Community High School (city school, graduating class of 323 students)

ASPIRATIONS

Blake finds clients through an informal, word-of-mouth business that he operates from his apartment, though he struggles to find work during the winter months. A friend suggested he create a website.

BACKGROUND

Blake was raised in a medium-sized town in Oklahoma, where he still lives. In high school, he focused on playing football and baseball; he earned mediocre grades, likely due to undiagnosed learning difficulties.

Blake grew up food insecure in a large family that relied on government food assistance.

PERSONAL

He co-parents a three-year-old with his former girlfriend and spends much of his free time gaming.

Reimagining CS Pathways
High School and Beyond

Caroline Cohen

Legislative Aide

CURRENT JOB

Caroline works as an aide for a member of the U.S. House of Representatives.

LOCATION

Washington, DC

EDUCATION

- B.A. in History and Political Science from an Ivy League School

ASPIRATIONS

The congresswoman for whom Caroline works will soon be questioning three big tech CEOs during congressional hearings about the role that social media plays in shaping the mental health of teenagers. Caroline has been tasked with writing the first draft of the brief that the congresswoman will read in preparation for the hearing and the question list that she will consult during the hearing. She wants this first draft to be successful and complete.

BACKGROUND

Caroline was raised in Miami, Florida, by parents who work in the hospitality industry. She often helped in the hotel where they worked.

Caroline has been interested in politics from a young age – her dads will recount how when she was in the third grade, she excitedly colored states red and blue as results came in on election night.

PERSONAL

Caroline spends her free time working out and watching Netflix.

Izabel Pérez

Restaurant Server

CURRENT JOB

Izabel is a server at a local diner.

LOCATION

Manito Plains, Kansas

EDUCATION

Graduated from Manito Plains High School (graduating class of 301 students)

BACKGROUND

Isabel was born in a medium-sized city, where she still lives. As a result of prenatal drug exposure, she has some executive processing issues which made school work especially challenging for her. These challenges were compounded by her mother's incarceration and her father's intermittent drug use. She was relieved to graduate from high school. She enjoys her work in a restaurant, particularly developing relationships with her 'regulars.'

PERSONAL

She chooses to spend some of her free time volunteering at a shelter for children who are waiting for placement in foster care. The problems that she has witnessed in her city's response to abused and neglected children – including her own experiences – have led her to an emerging desire to be more active in the political process. This, in turn, has led her to want to know more about other political issues, including those related to topics such as data privacy and the regulation of artificial intelligence (including AI-delivered rulings and sentencings), self-driving cars, and services such as Airbnb.

Liam Cooper

Barista

Reimagining CS Pathways
High School and Beyond

CURRENT JOB

Liam works as a barista in a resort town.

LOCATION

Vail, Colorado

EDUCATION

Graduated from Springfield High School (rural school, graduating class of 47 students)

BACKGROUND

Liam was raised in a rural area of Colorado by parents who struggled to find well-paying jobs as a result of their limited education and skills. He was not particularly engaged in high school. After graduation, he moved to a nearby town in Colorado with a ski resort, where he works as a barista. He lives with several roommates due to the high cost of housing in the area.

PERSONAL

Liam spends much of his free time hiking or snowshoeing, depending on the season.

ASPIRATIONS

Recently, he has heard talk that most of the baristas will be laid off when the shop installs a largely automated system that will prepare menu items, including drinks and pastries, as customers order them. Liam keeps hearing ads in his music streaming service for something called 6BootAI, which is a bootcamp that he can attend at no cost to learn AI skills; once he gets a job, he will owe 6% of his wage to 6BootAI for six years.

Marisol Rodríguez

Virual Reality Social Media Manager

Reimagining CS Pathways
High School and Beyond

CURRENT JOB

Marisol currently works full-time as a virtual reality social media manager at a wellness start up.

LOCATION

San Marcos, Texas (medium-sized city)

EDUCATION

- Associate's degree in Communication from Lone Star Community College
- Graduated from Penlow High School (rural school, graduating class of 38 students)

ASPIRATIONS

Marisol would like to be a parent soon and is considering a new job that would give her more scheduling flexibility and less pressure.

BACKGROUND

Marisol grew up in a rural area located half-way between two large Texas cities. She is part of a large extended family that has lived in Texas since it was part of Mexico, most of whom are skilled laborers.

As a result of a childhood injury, Marisol has used a wheelchair since she was in elementary school.

PERSONAL

Marisol spends much of her free time gaming. While she enjoys it, she is frequently frustrated by the lack of representation of people with mobility issues.

Serenity Jin

High School English Teacher

Reimagining CS Pathways
High School and Beyond

CURRENT JOB

Serenity currently works as an English teacher at Wyman Community High School.

LOCATION

Wyman, California (near San Diego)

EDUCATION

- B.A. in English from University of California Los Angeles
- A.A. in Teacher Education from Los Angeles County Community College
- Graduated from Whitfield Community High School (urban school, graduating class of 1,263 students)

ASPIRATIONS

Serenity looks for ways to use technology tools to make the best use of her limited time and to help her students, particularly those who are struggling for various reasons.

BACKGROUND

Serenity was raised in the suburbs of Los Angeles by a single mother who immigrated from China and worked as a home health aide. Serenity doesn't know anything about her father.

Her high school attendance was irregular due to high levels of anxiety. A committed high school counselor helped her find ways to manage her anxiety, improve her school attendance and performance, and apply to college.

PERSONAL

Serenity is recently married; she and her partner have two fur babies and enjoy spending time at the beach.

Victoria Hansen

Construction Worker

Reimagining CS Pathways
High School and Beyond

CURRENT JOB

Victoria works as a construction worker building roads.

LOCATION

Roswell, New Mexico

EDUCATION

Earned G.E.D. at age 20 (attended 3 years in high school)

BACKGROUND

Victoria, who identifies as non-binary, was raised in an upper middle class suburb in Arizona by an elderly aunt.

In high school, Victoria gave birth to a baby at aged 17. After dropping out, they took on various part-time jobs to make ends meet.

PERSONAL

They enjoy spending time with their child outdoors, visiting parks and the local zoo.

ASPIRATIONS

Victoria is concerned about the recent adoption of a facial recognition system for attendance and security in her child's school. Though they would like to raise these concerns, they are unfamiliar with the processes for doing this or even who to talk to about these concerns.

Appendix D: Summary of the Foundational Content

<table>
<tr><th>DISPOSITIONS

Encompasses all content</th><th>IMPACTS AND ETHICS
Applies to each topic</th><th>DESIGN THINKING
Applies to each topic</th><th>INCLUSIVE COLLABORATION
Applies to each topic</th><th>COMPUTATIONAL THINKING
Applies to each topic</th></tr>
<tr><td>ALGORITHMS</td><td colspan="4">Define algorithm, including traditional and AI/ML algorithms
Compose, modify, and interpret algorithms
Decompose a problem into multiple subproblems
Evaluate aspects of different algorithms</td></tr>
<tr><td>PROGRAMMING</td><td colspan="4">Convert an algorithm to code
Modify a program
Articulate whether a program solves a given problem
Systematically test and debug a program</td></tr>
<tr><td>DATA AND ANALYSIS</td><td colspan="4">Describe, at a high level, the role of data in AI/ML applications
Manipulate (e.g., normalize, transform, clean) data
Trace how data moves through a program
Evaluate data visualizations
Work with large data sets</td></tr>
<tr><td>COMPUTING SYSTEMS AND SECURITY</td><td colspan="4">Identify various types of hardware and software
Describe why/how cybersecurity is important
Explain what networks (including the Internet) are and how they work
Apply troubleshooting strategies to identify and fix problems
Use documentation and other resources to guide tasks</td></tr>
<tr><td>PREPARING FOR THE FUTURE</td><td colspan="4">Explore pathways and careers that involve computing
Apply computing concepts to other academic disciplines
Examine how emerging technologies are impacting a variety of practices
Evaluate the use of emerging technologies
Plan how an emerging technology could meet a need</td></tr>
</table>