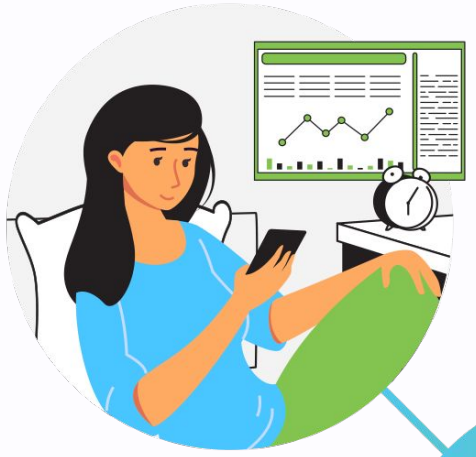
Reimagining Computer Science Education

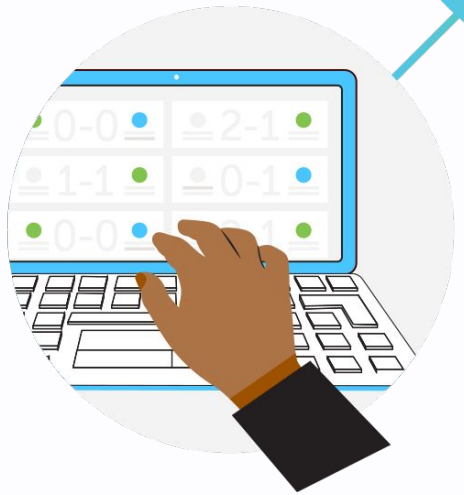
I don’t know if my personal data is safe if I use this sleep app – Could I create my own app?

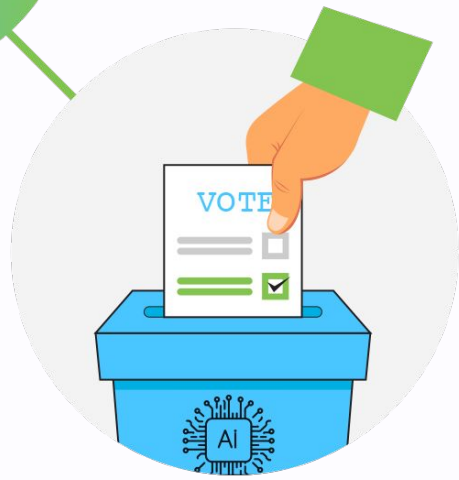


An ad just recommended that I try that bakery – Is something tracking my location?

Every student prepared for a world powered by computing

Tracking data for my soccer team takes a lot of time – Should I automate the process?





Should I vote for the candidate who promised to regulate AI?

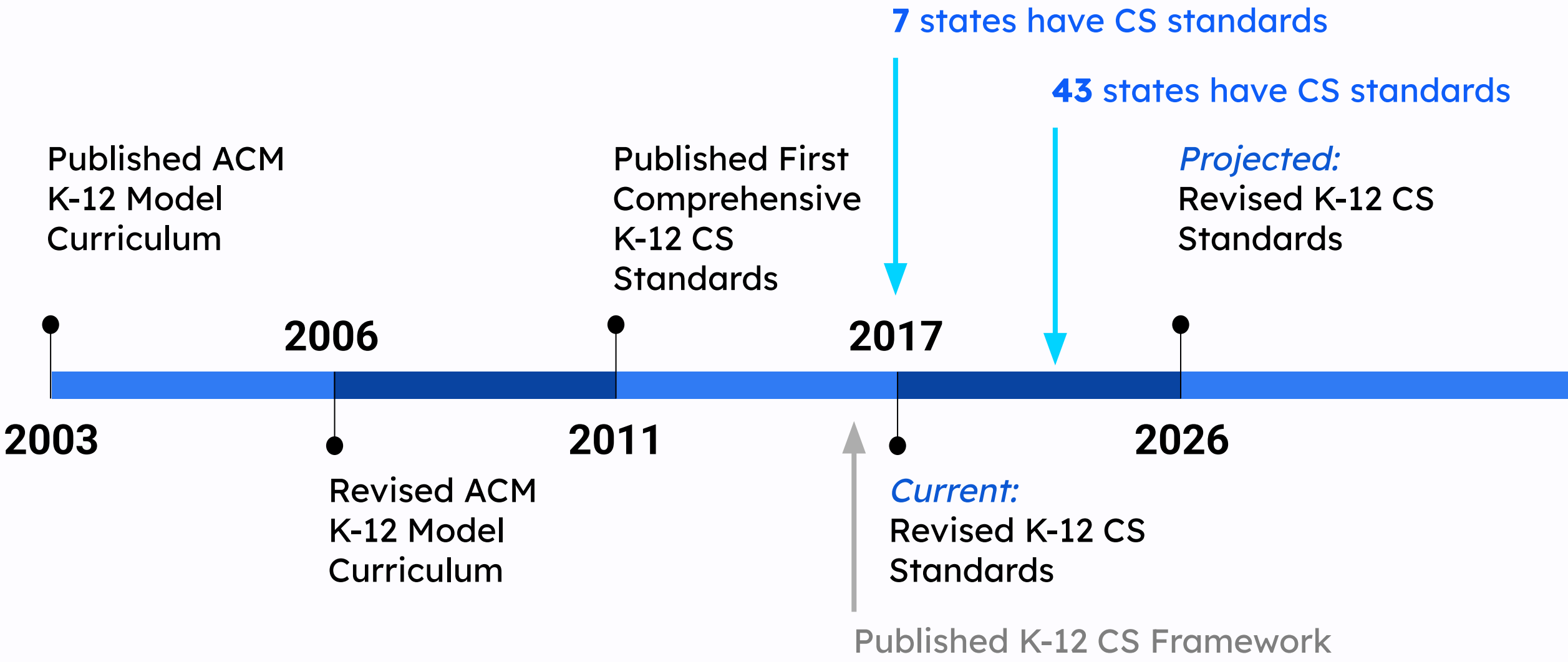
Our Vision for the Future of K-12 CS Ed

In a world increasingly powered by computing, students of all identities and chosen career paths need quality CS education to become informed citizens and confident creators of content and digital tools.

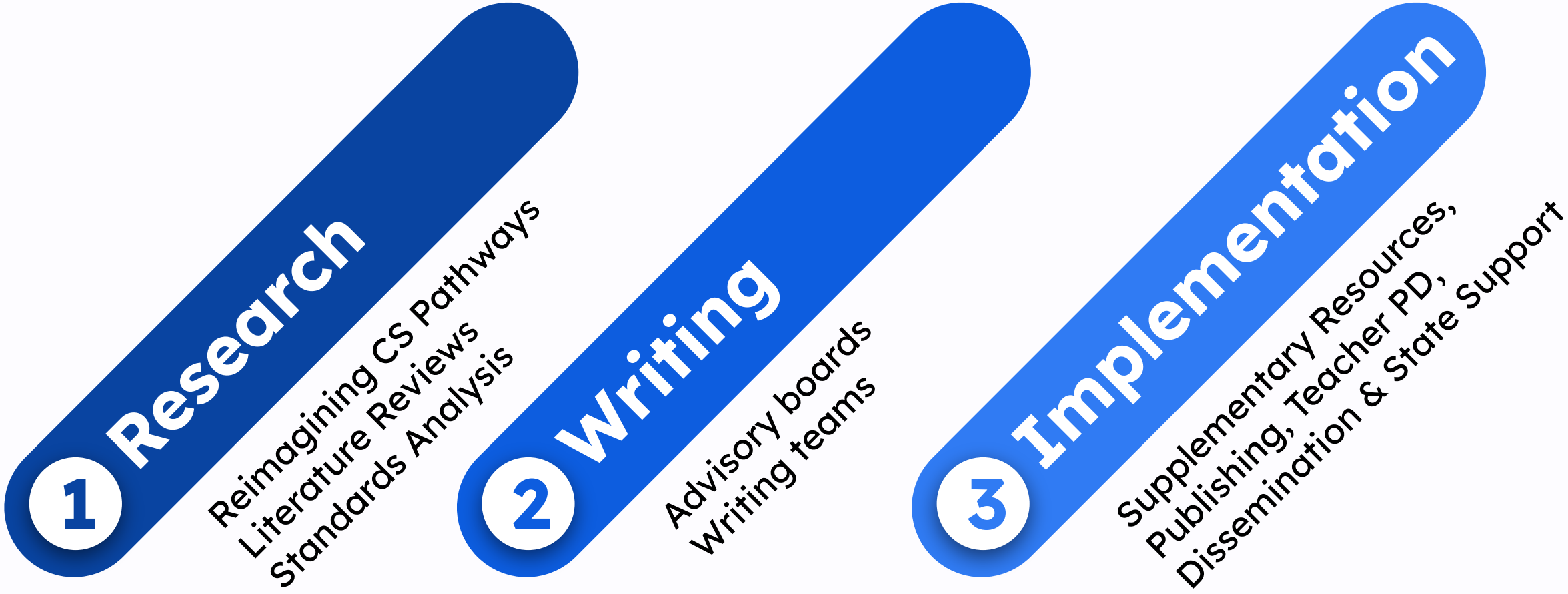
The Need to Reimagine CS Education

- **Surge in Interest**
  A burgeoning number of K-12 and postsecondary students is interested in minoring or majoring in CS or just taking individual CS courses in college.
- **Graduation Requirements**
  States are increasingly adopting policies that require CS learning for high school graduation.
- **Greater Diversity, Experience**
  The recent K-12 CS movement has led to a population of K-12 students interested in CS that is more diverse in demographics and interests and has more CS experience than previous generations of students.
- **Advances in Computing**
  There is a growing significance of and need for CS skills including high-demand topics such as artificial intelligence, data science, and cybersecurity.

History and Future of the CSTA K-12 Standards



Planned Phases



Reimagining CS Pathways

High School and Beyond

Reimagining CS Pathways
High School and Beyond

Overview & Goals

We convened representatives from K-12, higher education, and industry across the U.S. to develop community definitions that answer two key questions:

1. What **CS content is essential** for all high school graduates to know?
2. What **pathways** should exist to continue learning beyond the foundational high school content?

CSTA
Computer Science Teachers Association

ACE
INSTITUTE for ADVANCING COMPUTING EDUCATION

acm Association for Computing Machinery

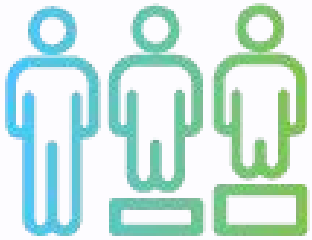
CODE

CollegeBoard

CSforALL

ECEP Expanding Computing Education Pathways

Guiding Values



Equity-centered

Promotes broad and equitable access, participation, and experiences in CS education among all high school students.

Community-generated

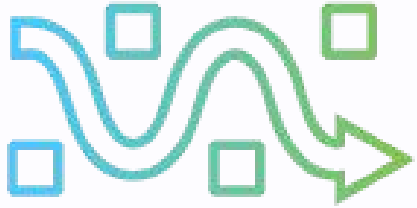
Meets the needs of the community, including K-12 educators, postsecondary institutions, students, parents, and industry.

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 CS.



Flexible in implementation

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

Outputs

- Foundational content
- Example CS pathways
- Guidance for implementation
- Framework for replicating the process

Will directly inform

- CSTA K-12 CS Standards revision
- Future updates to AP CS courses

Reimagined Foundational CS Content

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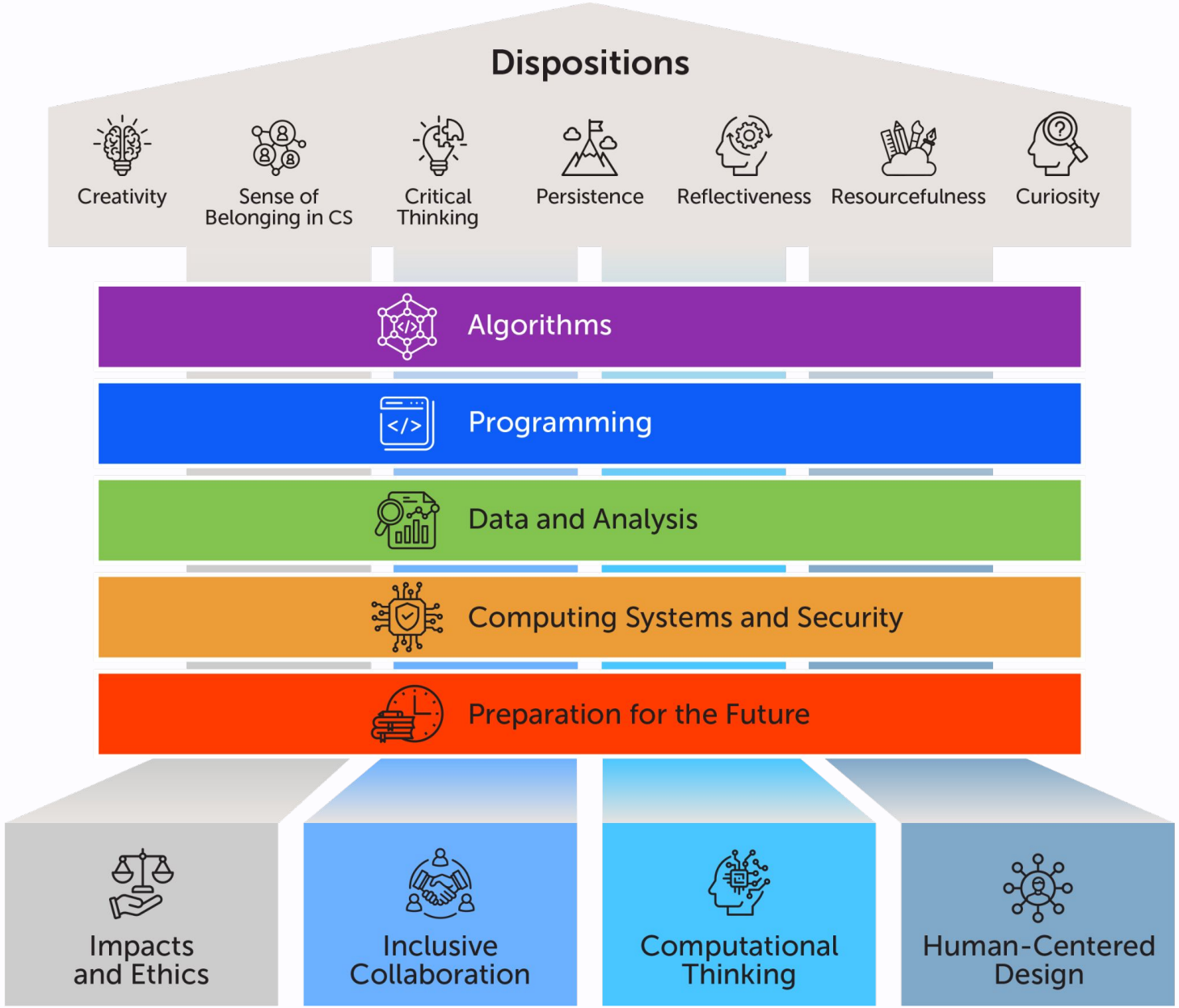


Learning Outcomes by Bloom's Level

Table 2.5.2.1: Programming foundational content.

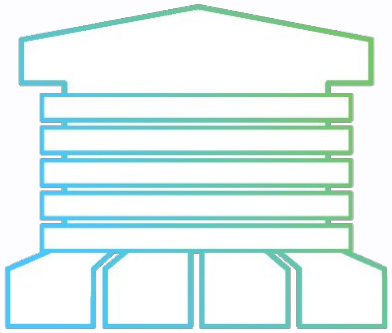
Level	Learning Outcome
Remember	PR.1 Reference documentation and other online tools to assist with programming
Understand	PR.2 Convert an algorithm to code
	PR.3 Interpret the function of a segment of code
Apply	PR.4 Modify a program (e.g., add functionality or improve usability or accessibility)
	PR.5 Use prompt engineering, code generation tools, or other AI technologies to plan, write, test, and debug code[CT]
	PR.6 Document a program to clarify functionality (e.g., using comments within code)
	PR.7 Apply principles of inclusive collaboration to a programming project[IC]
Analyze	PR.8 Articulate whether a program solves a given problem[CT]
	PR.9 Use computational thinking principles to analyze a program[CT]
Evaluate	PR.10 Test and debug a program systematically[CT]
	PR.11 Evaluate whether and how computation can or cannot help solve a problem
	PR.12 Assess societal impacts of programming and related ethical issues (e.g., how might modifications to a program impact various groups of users?)[IE]
Create	PR.13 Design a program using principles of human-centered design[HCD]
	PR.14 Develop programs using sequence, selection, and iteration

Integration of Pillars and Dispositions into Topic Areas

 Impacts and Ethics	 Inclusive Collaboration	 Computational Thinking	 Human-Centered Design	  Dispositions
Explore a program's implications for data privacy and security	Work in diverse teams to develop a program	Apply knowledge of programming patterns to new contexts	Interview users to understand their needs	Reflect on one's choice(s) to emphasize speed, cost, efficiency, accuracy, etc. in the design of a program
Examine how biases might arise in a program's output	Collaborate via peer code reviews	Explore whether and how a problem can be solved without computing, then transform into a program as appropriate	Develop an app that is accessible to vision-impaired users	Apply universal design for learning concepts to improve sense of belonging

Specialty Area Content Progressions

Foundational CS Content	Fundamentals	Specialty



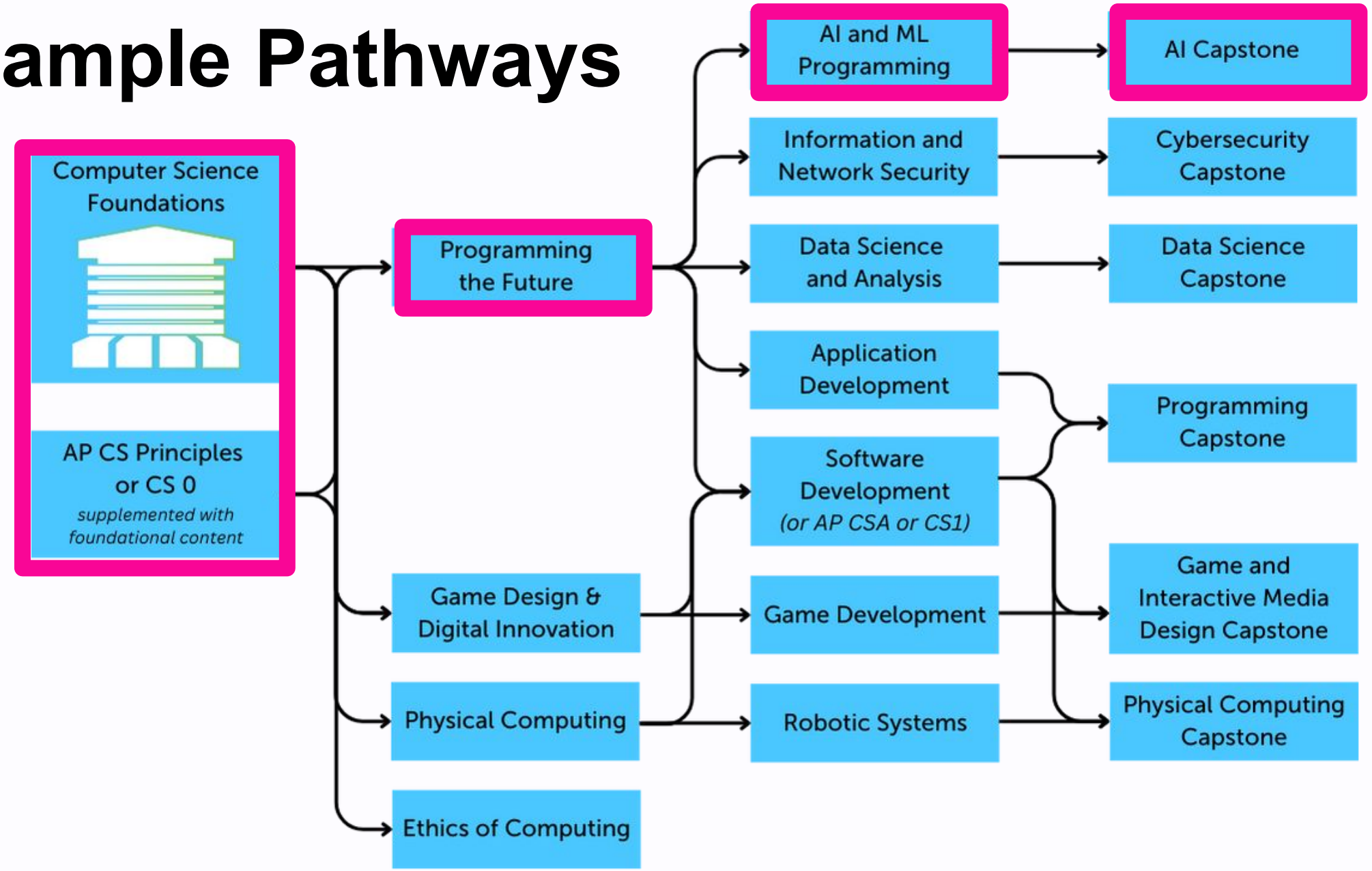
Prioritized foundational content specific to AI:

- How algorithms are used
- Difference between traditional and AI/ML algorithms, including the role of data in AI/ML
- Patterns/commonalities in problems, data, and programs
- Evaluate outputs for biases and accuracy
- Societal impacts of AI (e.g., biased data, attribution)

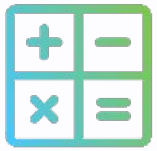
- What is AI: history, levels of AI, future careers, laws
- Intro to AI programming and intro to prompt engineering
- AI projects
- Natural interaction, semantics, chatbots
- Representation and reasoning, k-nearest neighbors (KNN), vectors
- AI programming (projects), using AI tools to solve problems
- Ethical frameworks, philosophy, psychology, bias
- Sensors, perception, classification
- Using datasets, regression, probabilistic thinking
- Convolutional neural network (CNN), decision trees, bias
- Ethical design and empathy

- Fundamentals of electronics, mechanisms, circuits, gears, sensors
- Computer vision, sensor applications, models, perceptions
- Robot hardware manipulation (or software simulators)
- Using data: collection, cleaning, data types, validity, bias
- ML models: optimization, accuracy, decision-making, ethical considerations
- Linear algebra, matrices, vectors, probability, statistics
- Programming applications with math
- Biases in data collection, analysis, and reporting
- Preparation for industry

Example Pathways



Integrating CS

Subject Area	Example Integration of AI Content	Content Alignment Example
Social Studies (including Civics and Ethnic Studies) 	• What is AI?: history, levels of AI, future careers, laws • Ethical frameworks, philosophy, psychology, bias • Ethical design and empathy interviews • Biases in data collection, analysis, and reporting • Using AI tools to solve problems	Exploration of AI ethics aligns with this item in the New York Learning Standards for Social Studies: "Prepare a plan of action that defines an issue or problem, suggests alternative solutions or courses of action, evaluates the consequences for each alternative solution or course of action, prioritizes the solutions based on established criteria, and proposes an action plan to address the issue or to resolve the problem." **Sample activity:** Students develop a plan of action related to the environmental costs of developing LLMs.
Mathematics 	• Representation and reasoning, KNN, vectors • Using datasets, regression, probabilistic thinking • Using AI tools to solve problems • Linear algebra, matrices, vectors, probability, statistics • Programming applications with math	Using datasets aligns with this item in the Texas Mathematics Essential Knowledge and Skills: "Students will extend their knowledge of data analysis and numeric and algebraic methods." **Sample activity:** Students analyze the output of unsupervised learning models that categorize data.

Some of the seemingly intractable problems of our current and future generations may be tackled by the very students who sit in the classrooms today learning the future of technology and weighing its ethical implications.

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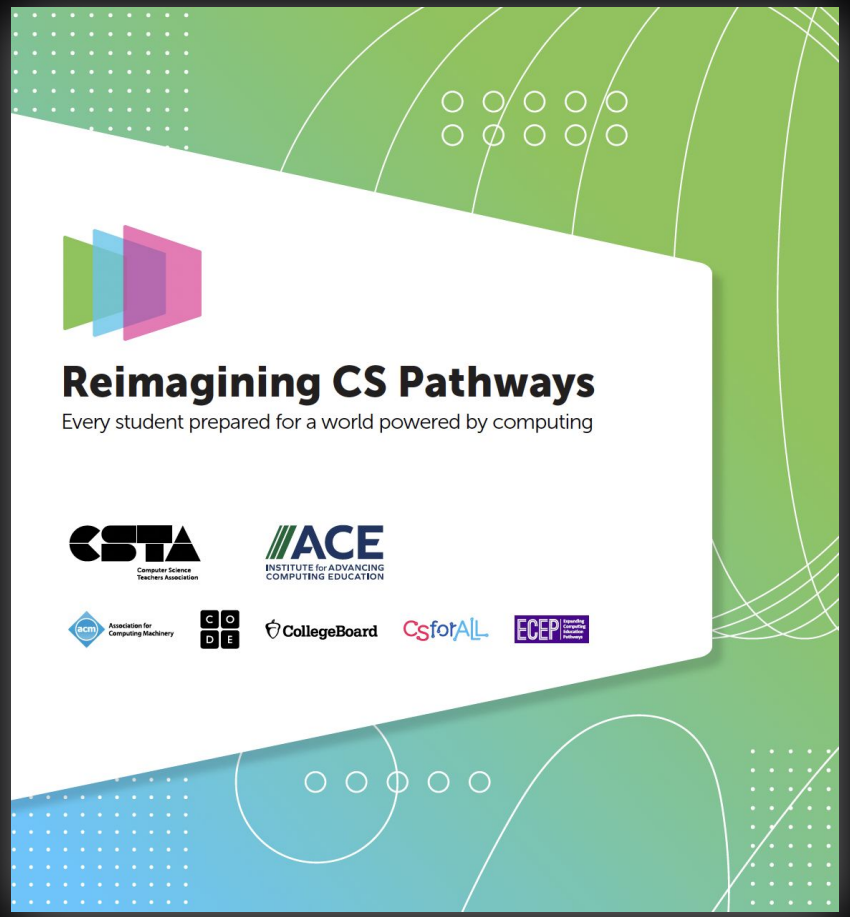

1. Introduction & Vision
2. Foundational Content
3. Learning Beyond the Foundation
4. Moving Toward Implementation
5. Example Courses & Pathways
6. Integrating CS
7. Centering Equity
8. Key Recommendations
9. Process and Challenges
10. A Toolkit for Reimagining CS
11. Conclusion & Appendices

Acknowledgements

- Steering committee
- Advisory board
- Convening participants
- Focus group participants
- Reviewers
- CSTA & IACE staff
- NSF

This material is based upon work supported by the National Science Foundation (NSF) under Grant No. 2311746. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.

Teachers are rockstars.

How can you make them feel this?