NATIONAL ACADEMIES *Sciences Engineering Medicine*

# Data and Computing in K–12 Education

## Foundational Competencies

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**Download the report**
nationalacademies.org/data-computing-ed

# Why this report — and why now?

### Computing

CSforAll has expanded but unevenly. Few students take CS or data science. K–5 is especially thin.

### Data

Long history in math and science but not explicitly addressed/ mostly as bolted-on statistics units. New trend: DS4Everyone

### AI

Arrived faster than any school system can absorb. Risks becoming yet another silo. AI4All/AI4K12….

### Quantum Computing

Calls for K-12 quantum curricula are already growing, before the field has settled what AI literacy should look like.

### ???

> *New advances in computing will keep emerging — quantum, AI, whatever's next.*
>
> *Teaching each new technology with a new course is unsustainable.*

— *paraphrased from Conclusion 2-1, p. 2-25*

*There have been efforts to integrate computation (and data) into K-12 classrooms, transforming what and how we teach. But all too often they have been piecemeal and fragmented, leading to a messy garden without a cohesive vision.*

# The Challenge

## Many disparate advocates and efforts

CS, data science, AI, and QIS advocates are each pushing to add their own content

## Crowded curriculum

K–12 is already stretched ➔ finding space for new material is genuinely difficult

## Growing urgency

As technology reshapes work and society, preparing students has never been more critical

# Statement of Task

To advance national conversations about the role of K-12 education in developing students' competencies in data and computing, the National Academies of Sciences, Engineering, and Medicine will convene an expert committee to conduct a consensus study that will identify competencies needed for students to navigate and succeed in the changing computational landscape and describe the role that K-12 education can play in the development of these competencies. The committee will give particular attention to approaches and experiences that promote the success of all students. The committee will address the following questions:

- What are the shared foundational competencies associated with the range of fields related to computing including data science, artificial intelligence, machine learning, and computer science? What competencies might be unique to these different fields? How are the foundational competencies for these fields related to foundational competencies in other STEM fields?
- What competencies and awareness are needed for learners to develop basic literacy in data and computing?
- What are the learning progressions needed to reach these competencies (for both basic literacy and to pursue careers)? What is developmentally appropriate? How are these competencies currently captured in existing content areas in school? At what point is it necessary to provide specialized training?
- What are the ethical practices and reasoning competencies that need to be considered? Are these practices and competencies adequately addressed in other school subjects?
- What should relevant learning experiences look like in practice and how might these experiences be tailored to meet students' interests and lived experiences? What are examples of programs or approaches that hold promise for developing the necessary competencies? What are the tradeoffs and affordances between different pedagogical tools and curriculum? What kinds of opportunities exist for building high-quality learning opportunities related to data and computing into existing school subjects?
- What are the implications for K-12 curricula? What might be done in the short-term and what long-term transformation might be necessary for the development of equitable opportunities? To what extent are separate pathways needed for different specialties? How could existing STEM subjects be revised to include opportunities to learn about computing and data?
- What research is needed to provide an evidence base for advancing the development of competencies in data and computing that promote the success for all K-12 students?

# Statement of Task

*Identify competencies needed for students to navigate and succeed in the changing computational landscape, and describe the role K–12 education must play.*

1. What competencies and awareness are needed for learners to develop basic literacy in data and computing?
2. How are the foundational competencies for these fields related to foundational competencies in other STEM fields?
3. What should relevant learning experiences look like in practice and how might these experiences be tailored to meet students' interests and lived experiences?
4. What are the implications for K–12 curricula and the broader education ecosystem?

# Study Process

- 16-member interdisciplinary committee supported by staff from BOSE, BMSA, and CSTB
- Committee met multiple times in 2024–2025
- Three public fact-finding meetings (2024–2025)
  - NSF charge & State-level landscape (ECEP, Data Science 4 Everyone)
  - Classroom implementation; professional organizations (CSTA, NCTM, NSTA, ASEE)
  - Assessment and Connections to Career & Technical Education
- External review of report
- Report release in March 2026

# Study Sponsor

National Science Foundation

# Study Committee

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Michigan State University

# What's in the report

*340 pages, 9 chapters:* ***where we are → what students need → how to get there***



21 conclusions · 14 recommendations · 32 research questions

# Current Context

*Organizations, Initiatives, & the K–12 Landscape*

Chapter 2

# Built on Existing Frameworks & Standards

Computer Science Framework & Standards

Data Science Progressions

NCTM Standards & Common Code Mathematics

Statistics (GAISE)

K–12 Science Framework & NGSS

AI4K12.org & QIS

# Foundational Competencies

*7 Competencies for All K–12 Learners*

Chapter 3

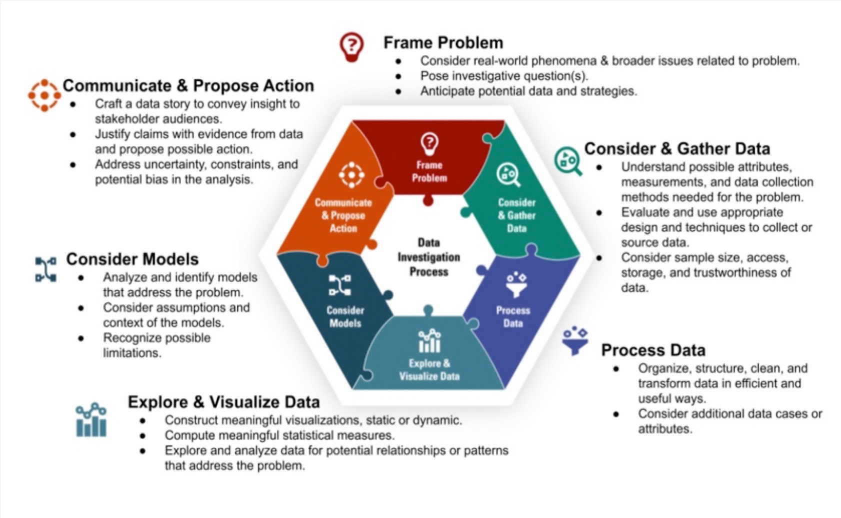
# The 7 foundational competencies for data & computing

| | | |
|---|---|---|
| 1 | Problem posing & problem-solving | *Define, attempt, reflect, iterate* |
| 2 | Producing & working with data | *Generate, clean, organise, explore* |
| 3 | Abstraction, algorithmic thinking, automation | *CT extended to data and to AI* |
| 4 | Probabilistic & inferential reasoning | *Variability, uncertainty, inference* |
| 5 | Models & representations | *Construct, choose, critique* |
| 6 | Technology & society | *Ethics, power, structural analysis* |
| 7 | Data & computing systems | *Under the hood; trade-offs* |

COMPETENCY 1

# Problem Posing & Problem-Solving Processes

*Define, attempt, reflect, iterate*




## COMPONENTS

- Define a problem or question
- Identify the steps needed to address it
- Reflect on results and iterate

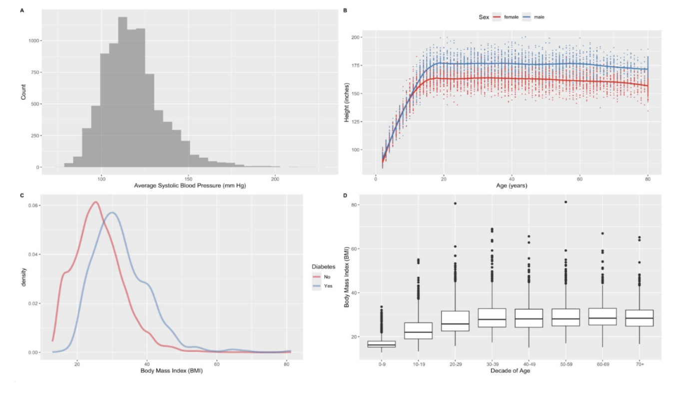
## KEY INSIGHTS

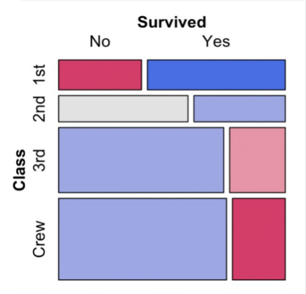
- Problems don't come pre-defined — students learn to formulate questions that data and computing can address
- Mirrors real-world process cycles: data investigation, computational creation, engineering design, scientific inquiry
- Emphasizes decomposition, pattern recognition, and reflective pauses to evaluate progress

COMPETENCY 2

# Producing & Working with Data

*Measure, organize, explore, visualize*




## COMPONENTS

- Produce data: measurement & data provenance
- Organize data: case/attribute structure & data moves
- Exploration & data visualization

## KEY INSIGHTS

- Data is actively "produced," not simply collected — every measurement involves decisions about what and how
- Data provenance matters: who collected it, when, where, why, and who was left out?
- Organizing data through wrangling, filtering, and aggregation is essential before meaningful analysis

COMPETENCY 3

# Abstraction, Algorithmic Thinking & Automation

*Simplify, systematize, scale*

Picture adapted from https://kantree.io/blog/tips/digital-workflow

## COMPONENTS

- Creating abstractions and applying them in programming
- Developing algorithmic thinking at small and large scales
- Recognizing and creating automated solutions

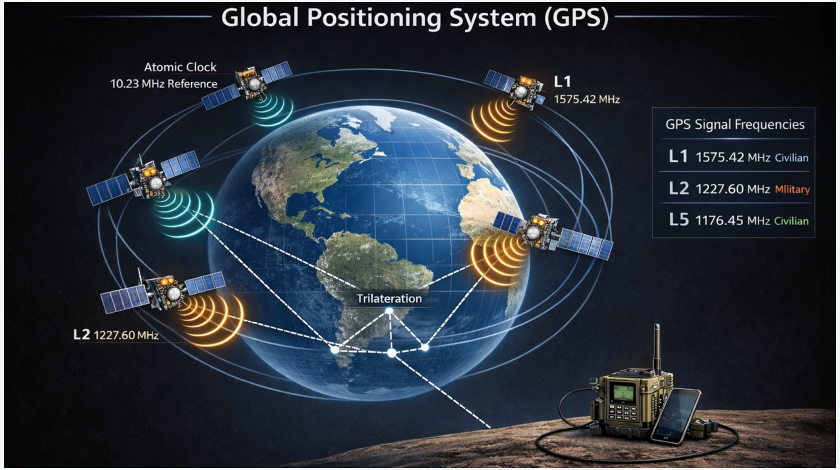
## KEY INSIGHTS

- Abstraction: focus on essential features, filter out irrelevant details — foundational across all STEM
- Algorithmic thinking: designing clear, logical step-by-step sequences including loops, conditionals, and functions
- Automation becomes necessary when scale grows — from thermostats to AI model training

COMPETENCY 4

# Probabilistic & Inferential Reasoning

*Variability, uncertainty, evidence-based conclusions*




https://www.tualcom.com/what-is-gps/

## COMPONENTS

- Identify sources and impacts of uncertainty & variability
- Recognize the roles of probabilistic, statistical, and deterministic reasoning and apply them
- Make inferences and predictions with appropriate degrees of certainty

## KEY INSIGHTS

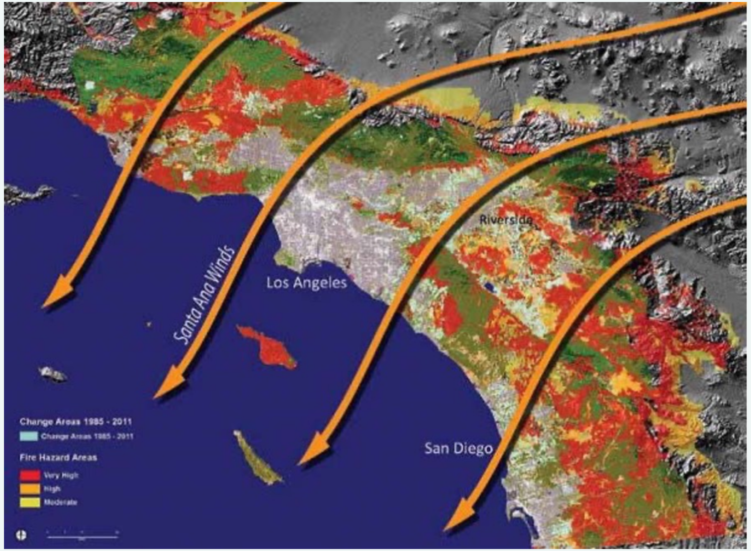
- Variability is everywhere — measurement, sampling, and natural variation all introduce uncertainty
- Students progress from informal inference (elementary) to formal hypothesis testing (high school)
- Critical for understanding AI and ML models, which produce probabilistic outputs, not definitive answers

4

COMPETENCY 5

# Models & Representations

*Construct, reason, assess, communicate*




## COMPONENTS

- Construct and use models and representations
- Assess the quality of models & representations
- Recognize limitations of all models and representations

## KEY INSIGHTS

- Models are tools that stand in for something real — from simple graphs to complex computer simulations
- All models involve assumptions and trade-offs; students must learn to evaluate fit and appropriateness
- Computational advances enable increasingly complex models, but “all models are wrong, some are useful”

COMPETENCY 6

# Technology & Society

*Ethics, values, impacts, responsibilities*

https://www.techpolicy.press/getting-beyond-minimizing-harms-of-algorithmic-systems/

## COMPONENTS

- Reasoning about process (how) & product (what)
- Reasoning about self and society

## KEY INSIGHTS

- Technology creates sociotechnical systems where social and technical elements are deeply interdependent
- Students weigh tensions: efficiency vs. craft, privacy vs. convenience, individual benefit vs. collective impact
- Biased data can lead to harmful outcomes in hiring, policing, lending — ethical reasoning is essential

COMPETENCY 7

# Data & Computing Systems

*Hardware, software, tools, and access*


https://robohub.org/svr-case-studies-lessons-for-robotics-from-enterprise-computing/

## COMPONENTS

- Recognizing elements of data & computing systems
- Selecting and using appropriate tools for the task
- Understanding ownership, openness, and access

## KEY INSIGHTS

- Systems span hardware to software, from personal devices to cloud computing, AI, and even quantum computers
- No single tool is best for all tasks — students learn to choose the right system for their purpose
- Issues of data privacy, ownership, consent, open source, and environmental impact of computing are paramount

# Existing frameworks map into the seven Cs

### CSTA K–12 CS Framework

Algorithms & Programming → C3 · Data & Analysis → C2, C4, C5 · Impacts of Computing → C6 · Computing Systems → C7

### NCTM Process Standards / CCSS-M Mathematical Practices

Problem solving → C1 · Reason abstractly & quantitatively → C2, C3, C4 · Model with mathematics → C5 · Reasoning & proof → C3, C4

### NGSS Science & Engineering Practices

Asking questions / Defining problems → C1 · Analyzing & interpreting data → C2, C4 · Using mathematics & CT → C3 · Developing & using models → C5

### GAISE II (statistics)

Investigative cycle (formulate / collect / analyze / interpret) → C1 · Data production → C2 · Variability & inference → C4 · Models → C5

### AI4K12 — Five Big Ideas

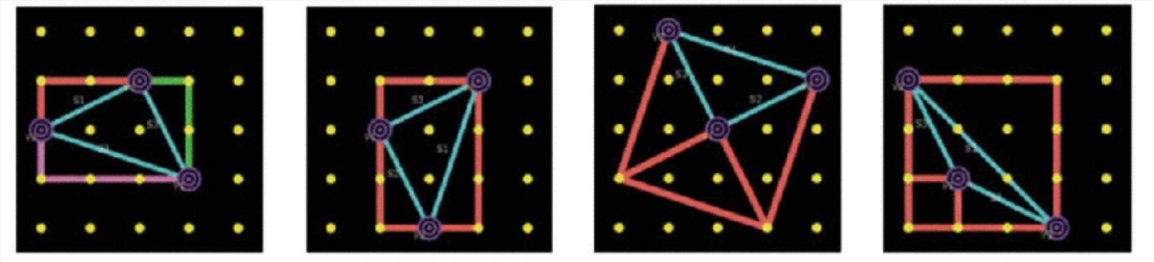
Perception, Representation & Reasoning, Learning → C5 · Natural Interaction → C2, C5 · Societal Impact → C6

### DS4E Learning Progressions

Investigation & questioning → C1 · Data work → C2 · Models of data → C5 · Data ethics → C6

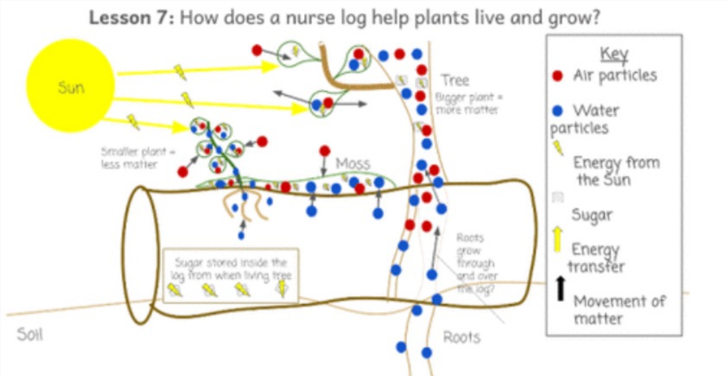
# Competencies & the Math Curriculum

Mathematics curricula often include some statistics and occasionally limited computing. Areas like measurement, algebraic thinking, probability, and modeling could be enhanced by more explicit connections to data and computing. Computing tools can support math instruction and help students see its real-world relevance.



# Competencies & the Science Curriculum

The foundational competencies relate to many science curriculum concepts including scale, proportion, systems models, asking questions, analyzing data, and computational thinking. Explicitly bringing these competencies into science courses would help students connect science concepts to data and computing topics.



# Effective Learning Experiences

## What is learning?

Active, social, constructive; builds on prior knowledge and lived experience

## Pedagogical considerations

Problem- and project-based learning; real-world contexts; ethics throughout; co-design

## Examples by grade band

Promising practices K–5, 6–8, 9–12 with a competency-by-competency walk-through

## Tools for data & computing integration

No "perfect" tool; choose for learning goals; CODAP, NetsBlox, Scratch, Jupyter notebooks

*Unplugged learning is valuable*

> *"Learning is an ongoing process that is **active**, **social**, and **constructive**, and that builds upon prior knowledge and the range of experiences one has.*
> *All of this has implications for students to see themselves as **knowers and doers** of data and computing."*

*The seven competencies are the **what**; chapter 5 discussed **how** to design experiences that help students learn these competencies **in context**.*

*What effective learning experiences that integrate data and computing might look like in practice at various grade levels, and how these experiences might be tailored to best serve students*

5-1

## Data and Computing learning experiences can (must?) connect to students' lives

Experiences can leverage prior knowledge, engage students with ethics and society, and be co-designed to connect to students' daily lives, schools, and communities.

5-2

## Data and Computing learning begins in elementary school

Grade-band competency examples show that foundational learning can start in elementary school. Middle and high school builds progressively so all students develop basic data & computing literacy.

5-6

## Opportunities for leveraging GenAI

Many K–12 students and teachers are now using generative AI. This presents an opportunity for lessons and discussions in schools on the practical and ethical issues related to use of AI, including how to evaluate the validity of AI outputs.

# Design of Curriculum

### Why integration over stand-alone

Reaches all students, not just elective-takers; coherence across grade bands

### Approaches to integration

Four levels: Superficial · Partial · Full · Disciplinary
(and what each demands of curriculum designers & teachers)

### Integration into math and science

Where data and computing connect to existing standards (NCTM, CCSS-M, NGSS)

### Examples by grade band

OpenSciEd 8.1 + CS · Algebra II + data science · scaffolded grade-band cases

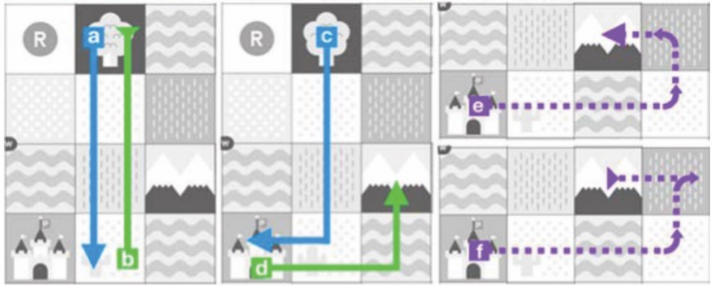
> *"Integration — making these connections in the context of courses that all students are already taking — allows broad exposure to the content for all"*
>
> *"Research evidence shows that the best way to support learning is through extended and recurrent lessons that connect to previous student experiences. This approach can provide coherence across grades and allow students to engage with progressions of relevant material of increasing depth and complexity over time"*

*Current K–12 curricula leave limited room for new stand-alone courses. A more coherent approach integrates foundational competencies into existing subjects — science, social science, and math — beginning in elementary school, helping students grasp complexity and connections across disciplines.*

# Elementary: mathematics though unplugged activities & coding robots

*Competencies : C1 (problem posing) · C3 (algorithms, sequencing, debug) + mathematics integration*

- Kindergarteners (ages 5–6) program two different robot toys to navigate a grid
- Preceded by unplugged sequencing — We're Going on a Bear Hunt, Robot Turtles, programming each other
- Small-group work with peer collaboration
- Children grappled with mathematics beyond standard kindergarten content: counting movements, one-to-one correspondence between physical moves and code blocks, counting from a starting point in space


*Shumway, J. F., Welch, L. E., Kozlowski, J. S., Clarke-Midura, J., & Lee, V. R. (2023). Kindergarten students' mathematics knowledge at work: the mathematics for programming robot toys. Mathematical Thinking and Learning, 25(4), 380-408.*

# Elementary School: CS+DS in Physical Education

*Competencies : C2 (working with movement data) · C3 (algorithms, sequencing) · C5 (representations)*

- Research-practice partnership: Northwestern + Evanston elementary coding and PE teachers
- Students program micro:bit wearables to track steps, laps, mile times during PE
- Scratch projects and movement-tracking activities co-designed across both classes
- Long-term engagement: same students experience CS and PE as connected, not separate
- Students develop concrete examples for otherwise abstract data and CS ideas


Figure 1: A demo screenshot of the Homecourt app's reaction drill (taken from Homecourt's website)

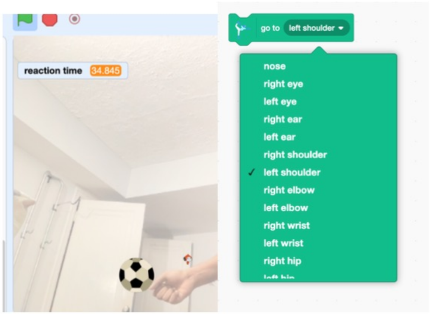


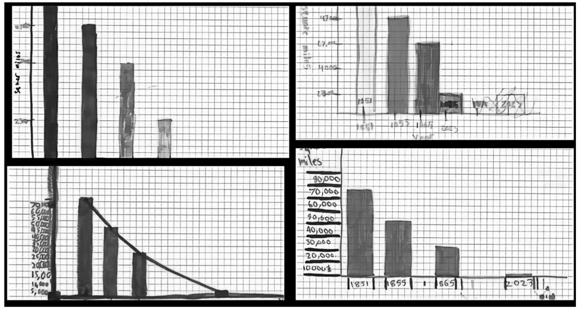

Figure 2: Screenshot of Scratch based reaction time game in action (left), and list of skeleton access provided by Body Sensing blocks

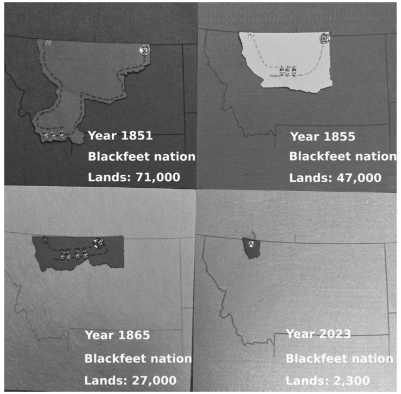
*Worsley, M. (2022, June). PE++: Exploring Opportunities for Connecting Computer Science and Physical Education in Elementary School. In Proceedings of the 21st Annual ACM Interaction Design and Children Conference (pp. 590-595).*

# Shrinking Lands: Computing+Data+Sociotechnical Inquiry

*Competencies : C1, C2, C2, C5*

- The Shrinking Lands project is part of a larger middle school social studies unit focused on treaties and sovereignty.
- Working with data to represent the population stats over time.
- Students construct and program a map using computational circuits (with Circuit Playgrounds Express) to display population changes over time in various locations within the United States.
- Engaging in data and computing to build artifacts that simultaneously interrogate socio-political power structures, promote culturally relevant pedagogy, student agency, and support student learning.
- Bridges computing + data practice work with the sociopolitical dimensions



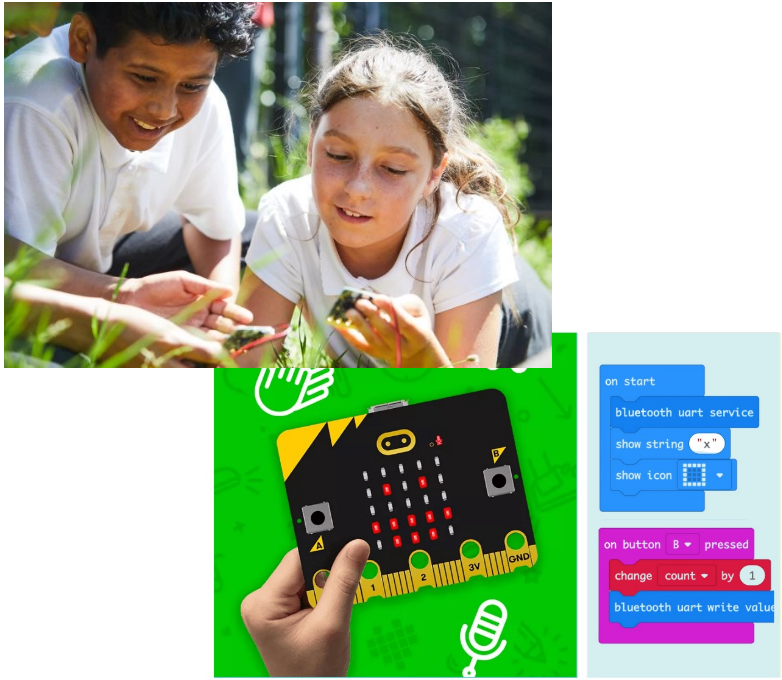



*Hansen, T., Searle, K., Jiang, M., & Barker, M. (2024). Shrinking Lands and Growing Perspectives: Affordances of Data Science Literacy During a Culturally Responsive Maker Project. In Improving Equity in Data Science (pp. 37-56). Routledge.*

# Middle school: Data Science for Social Good

*Competencies : C2 (working with real data) · C3 (algorithms across notations) · C6 (sociotechnical framing)*

- Middle schoolers in low-resourced rural areas worked on **data-science-for-social-good** projects
- Transition between the BBC micro:bit Block Editor and Jupyter Notebooks
- Design intent: focus less on syntactic differences, more on algorithmic reasoning
- Blocks-to-text is a known hard problem in CS education research

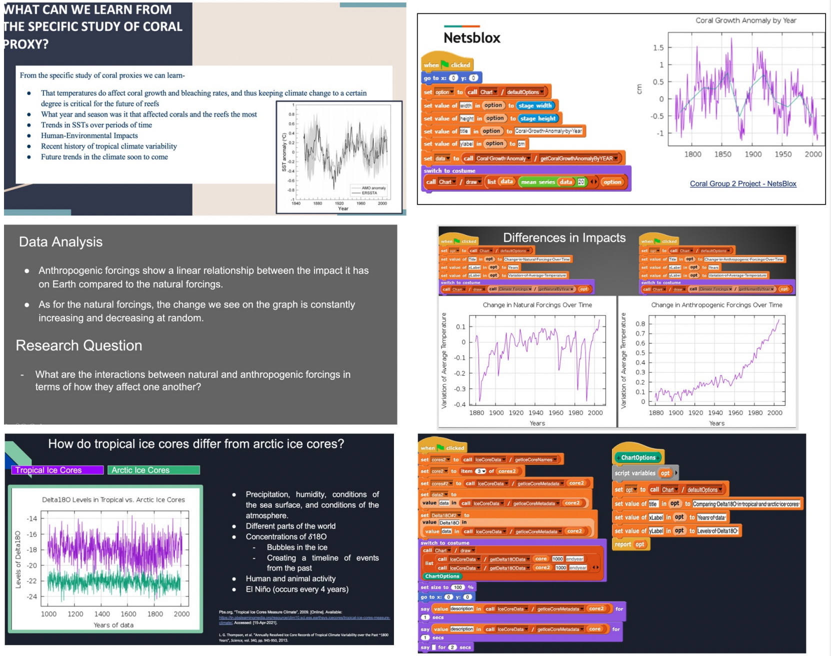



Bryant, C., Chen, Y., Chen, Z., Gilmour, J., Gumidyala, S., Herce-Hagiwara, B., ... & Rebelsky, S. A. (2019). A middle-school camp emphasizing data science and computing for social good. In Proceedings of the 50th ACM SIGCSE (pp. 358-364).

# High school: climate science, data science, computer science

*Competencies : C1.(research Qs) · C2 (data wrangling) · C3 (algorithms, automation) · C5 (statistical & mathematical models)*

- Out-of-school program designed to engage girls in climate research; led by women researchers (paleoclimatologist + science education researcher)
- 150 years of NOAA data: ice cores, atmospheric $CO_2$, global temperatures
- Students pose research questions about long-term climate patterns
- Wrangle and pre-process real datasets; build visualisations in NetsBlox (block-based)
- Use computational thinking to visualize and interpret statistical and mathematical models

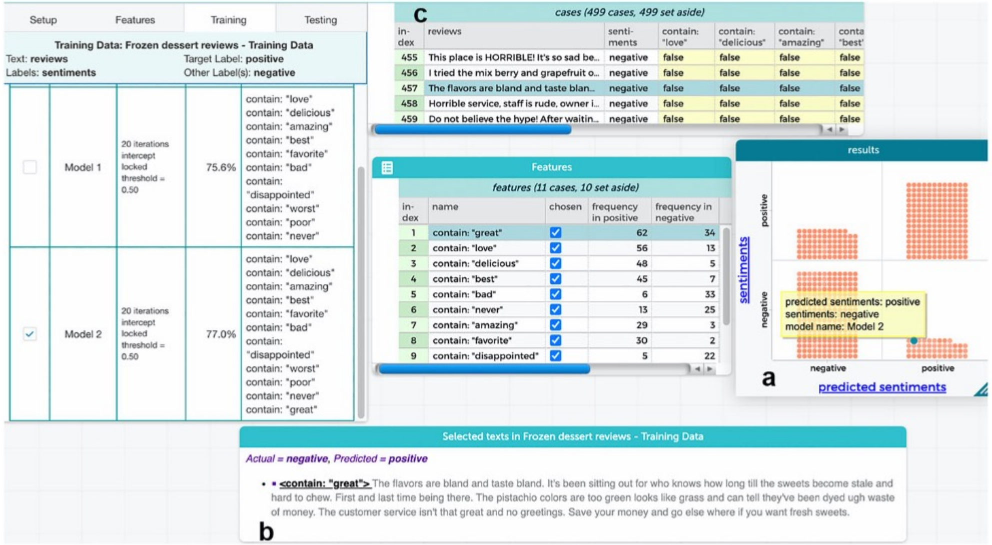



*Grover, S., Jean, D., Broll, B., Cateté, V., Gransbury, I., Ledeczi, A., & Barnes, T. (2024). Design of tools and learning environments for equitable computer science + data science education. In C. Tofel-Grehl & E. Schanzer (Eds.), Improving Equity in Data Science: Re-imagining the teaching and learning of data in K–16 classrooms (pp. 57–91).*

# High school: StoryQ on CODAP (ELA + AI/ML)

*Competencies : C1 · C2 · C3 · C4 · C5 · C6 · C7 (all 7 competencies)*

- HS students in a Journalism class train a sentiment classification model on a corpus of online restaurant reviews
- Iteratively select features, examine a confusion matrix, improve test-set accuracy
- Compares model predictions against human labels — students see where the model fails and why
- Demonstrates how natural language processing can be opened up at the high-school level




Jiang, S., Tang, H., Tatar, C., Rosé, C. P., & Chao, J. (2023). High school students' data modeling practices and processes: from modeling unstructured data to evaluating automated decisions. Learning, Media and Technology, 48(2), 350-368.

# Whither AI? How the report approaches AI

*"[Machine Learning] is one type of sophisticated modeling method that relies on advanced computing and huge data sources."*
*— NASEM (2026), Chapter 2*

### Foundations

AI literacy rests on a foundation of computational literacy and data literacy. Chasing each new technology with a new course is unsustainable.

### Teach about AI

The report scopes itself to teaching students about AI—not using AI as an instructional tool. The 'with AI' question is treated as an open research question.

### Beyond LLMs

While public attention focuses on LLMs, students will encounter many other types of AI. The framework is designed to absorb new forms.

*AI/ML is inextricably intertwined with CS/CT and data science*
*Data and data science are the connective tissue between CT and AI/ML* (Grover, 2024)

# Several AI-based examples

- **Fleischer, Podworny & Biehler, 2024** — Decision trees from data cards: *MS students construct data-based decision trees using physical data cards as a first introduction to machine learning.*
- **Jiang et al., 2023** — StoryQ on CODAP. *Data science / NLP / language: HS students train a sentiment classification model on online restaurant reviews, examine confusion matrices, iterate on accuracy.*
- **Lee & Perret, 2022** — AIMSinDS (AI Methods in Data Science): Teacher PD curriculum preparing high-school STEM teachers to integrate AI concepts, ethics of AI, AI careers, and conditions for selecting one AI model over another.
- **Driscoll & Kumar, 2025** — DoYouTrustAI: *A tool specifically built to teach students about AI misinformation and deepfakes. Cited in the references but with less elaboration than StoryQ.*
- **Janapa Reddi et al., 2021 / 2022** — TinyML in K–12. Making ML accessible at lower-resourced schools using small embedded systems.

# Several AI-based examples/references

- **Pet image classifier returning probabilities.** Used in Competency 4 to show how probabilistic reasoning underlies ML output.

- **Next-token generation in a generative AI model.** Used in Competency 4 and Competency 5 to ground the statistical foundations claim.

- **Facial recognition systems and algorithmic bias.** Used in Competency 6 as a case study of structural ethics.
- **Filter bubbles in recommendation systems**. Used in middle-school Competency 6 discussion.

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- **AI environmental cost.** Cites NEA 2025 and MIT News (Zewe, 2025) on energy use.

- **Bias and discrimination in AI systems.** Cites Benjamin (2019); Noble (2018); O'Neil (2016); Eubanks; Roselli et al. (2019); Zou & Khern-am-Nuai (2023)

- **2025 CSTA & AI4K12 AI Learning Priorities for All K–12 Students.** Flagged as the most recent attempt at a national AI-in-K-12 framework in addition to **AI4K12 Big Ideas**.

# AI in the Research Agenda

? How will the use of generative AI as an aid for coding impact the need for K–12 coding instruction? What are the anticipated shifts in teacher training, student content knowledge, and curricula?

? How can future instruction emphasizing new developments related to data and computing, such as AI and QIS, best maintain explicit continuity and connection to the foundational competencies?

? How does the use of AI in instruction impact students?

The growing use of generative artificial intelligence (AI) by K–12 students and teachers presents opportunities for learning about data and computing. It also provides motivation for lessons and discussions in schools on the ways that AI models work, practical and ethical issues related to use of AI, and ways to evaluate and assess the validity of AI outputs.

*How can the excitement/hype around AI be leveraged to teach the foundational competencies for data and computing?*

# Teacher Preparation & Transforming the K–12 System

# Teacher Preparation · Conclusions

7-1

## Instructional guidance is lacking — especially for K–5

The principles guiding how to integrate high-quality data & computing content into teaching are not well articulated. This gap is especially acute for elementary teachers.

7-2

## In-service development helps — but isn't widely available

Many teachers need new knowledge and pedagogical skills. Professional development can improve teaching, but it is not reliably supported by schools and districts.

7-3

## Preservice programs leave teachers underprepared

Many teacher candidates graduate without skills to facilitate data & computing in K–12. STEM methods courses that integrate computing and data could build teacher skills and confidence.

# Transforming the System

## National & State Level

Policy, standards coordination, and cross-sector alignment

## Local Level

School leaders as champions · Instructional support systems · Curricular materials

## Families & Communities

Engaging families and communities as partners in data & computing learning

## Out-of-School Time

After-school, library, and community programs as powerful learning spaces

### Conclusion 8-1

Fully achieving a system that prioritizes data & computing is complex. Both short-term and long-term changes are needed. A coherent, coordinated approach among curriculum developers, advocates, families, and educators could begin now — while policy changes around curriculum and teacher learning may take more time.

# Recommendations & Research Agenda

# Overview of the Recommendations

## Rec. 1–6 Adding Data & Computing to K–12

- **Rec 1.** Build data & computing into K–12 curricula coherently
- **Rec 2.** Adopt curricula that show cross-subject connections
- **Rec 3.** Start in kindergarten, progress through grade 12
- **Rec 4.** Evaluate impact on graduation requirements
- **Rec 5.** Use the seven competencies to guide design (incl. AI)
- **Rec 6.** Develop integrated resources with cross-disciplinary partners

## Rec. 7–9 Supporting Teachers

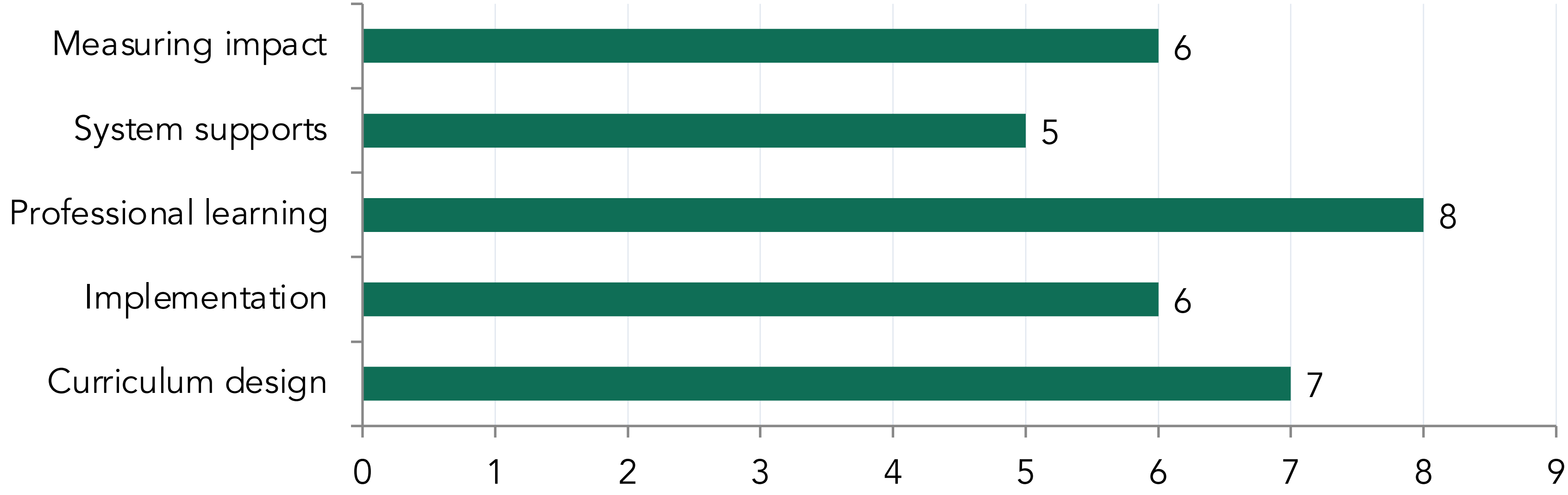
- **Rec 7.** PD that lets teachers experience competencies within their disciplines
- **Rec 8.** Expand preservice pathways with CS, math, stats, DS departments
- **Rec 9.** All preservice teachers gain familiarity with computing and data

## Rec. 10–14 Transforming the System

- **Rec 10.** Measure participation and outcomes across experience types
- **Rec 11.** Coordinate across professional societies and advocacy groups
- **Rec 12.** Fund curriculum, PD, tech (not contingent on vendor lock-in)
- **Rec 13.** Choose tools for accessibility, PD, cost, and data privacy
- **Rec 14.** Math/science/CS/stats/DS societies should revisit frameworks together

# The research agenda — 32 questions across 5 areas

*RQs are framed as illustrative, not exhaustive.*



# Selected Items from the Research Agenda

- ? What pedagogies best support student learning about data and computing? Is this consistent across the foundational competencies?
- ? How will the use of generative AI as an aid for coding impact the need for K–12 coding instruction? What are the anticipated shifts in teacher training, student content knowledge, and curricula?
- ? How does the use of AI in instruction impact students' learning of data & computing?
- ? What are common roadblocks & misconceptions related to the foundational competencies? Are there common pedagogical approaches across the STEM disciplines, or do we need new ones?
- ? What is the impact on young people's perceptions of various disciplines and what participation changes are seen when the foundational competences are integrated (e.g., does women's interest in biology decrease, does integration increase math self-identity, etc.)?

# Key Takeaways

### Risk of overload

Calls to add CS, data science, AI, and QIS to K–12 education could overwhelm the system if not done carefully and coherently.

### Common ground already exists

Shared competencies undergird all of these fields — and to a meaningful degree are already embedded in the K–12 curriculum.

### Three paths to better learning

(1) Make existing data & computing connections more explicit. (2) Enhance connections in science and math. (3) Expand the role of data & computing in K–12 learning experiences — starting in kindergarten.

# Discussion Questions

(1) Looking at the seven competencies, (a) which one(s) resonate(s) the most with how you already think about K–12 learning, (b) which one(s) that feel(s) hardest to pull off in real classrooms, and (c) what (if anything) feels missing?

(2) Are these competencies relevant to teaching AI in the disciplines? Why or why not? If yes, how?

(3) Competency 3 names abstraction, algorithmic thinking, and automation, but not **coding**. This framework has folded inside Competency 3. What are your thoughts on this? Is it a missing element worth naming explicitly? And does your answer change in the light of Gen AI?

(4) The report argues for integration over stand-alone courses. What might we lose with that choice?

(5) Anything else you'd like to share, discuss, react to?

# Thank You

Download the report and resources:

nationalacademies.org/projects/DBASSE-BOSE-23-04

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