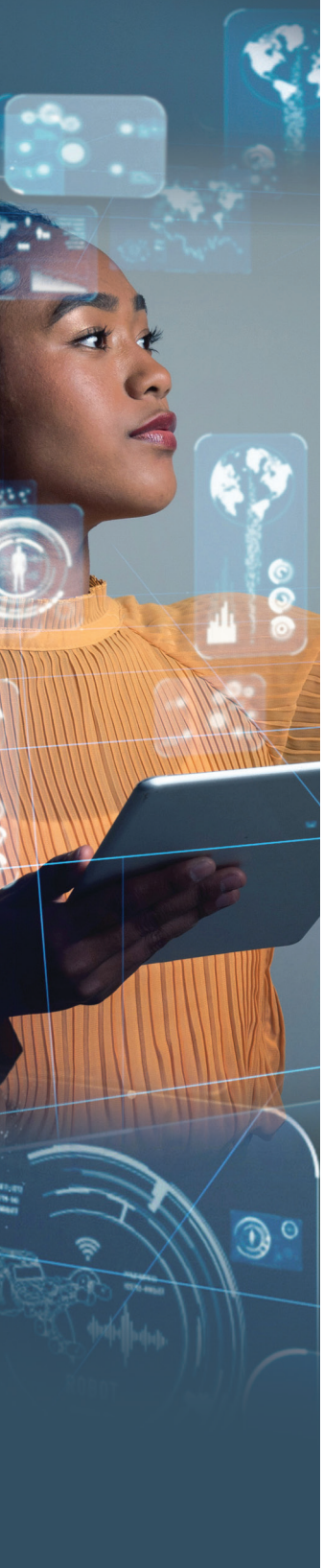

Cultivating Interest and Competencies in Computing

Authentic Experiences and Design Factors

Highlights for State, District, and School Leaders

This consensus study by the National Academies of Sciences, Engineering, and Medicine documents the evidence on the role of authentic science, technology, engineering, and mathematics (STEM) learning experiences in developing interest and competencies for computing. The authoring committee consisted of experts in the design and construction of learning spaces in formal and informal STEM and computing education settings. The full report includes the committee's findings, conclusions, and recommendations.

This brief presents five key takeaways and seven steps for action for state, district, and school leaders who design, implement, and support K–12 education programs—and the training, resources, learning experiences, and wraparound services that influence student learning.

Five Takeaways

1. **To thrive in our digital world, all K–12 students must develop computing competencies.** Computing touches nearly every facet of our daily lives, both personal and professional. Computing competencies are now critical not only in the technology industry, but in nearly every occupation—and computing will drive the careers of tomorrow that have yet to emerge. Developing computing competencies will prepare young people for informed civic engagement as well as for rewarding careers, strengthening the pipeline of talent for employers.

> Computing is more than coding or computer science. Computing refers to a broad range of foundational knowledge and competencies that cut across disciplines—including computer science and other STEM subjects. Engaging in computational thinking and using computational methods are important for solving problems in all fields, including the arts. Computing competencies are valuable because they are broadly relevant to personal life, professional pursuits, and civic participation.

2. **Computer science education is broadly supported in public policy and in K–12 institutions—but it's time to raise expectations and outcomes.** In response to widespread calls to expand access to computing-related learning experiences, 39 states have developed (or are developing) computer science standards over the past decade, and 19 states require all high schools to offer computer science. This national movement has both public- and private-sector support. However, while most K–12 students have access to digital devices, many schools still do not offer computing-related learning experiences beginning in the formative elementary and middle school grades. The bottom line: many students still have limited opportunities to develop critical computing skills.

The National Academies of
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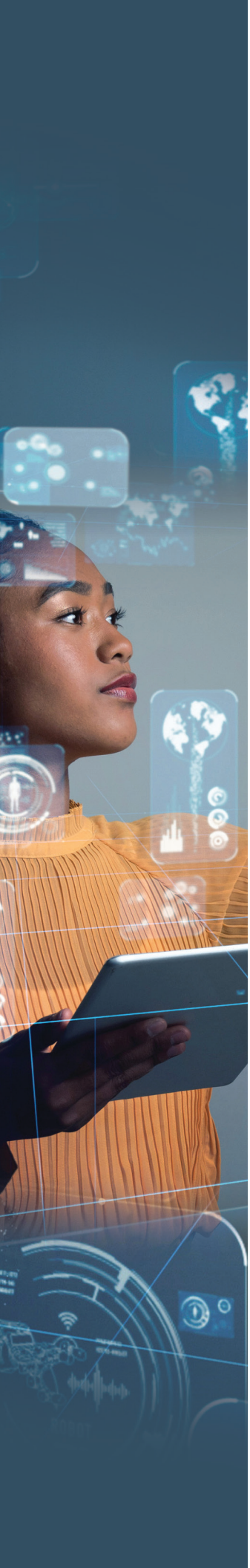


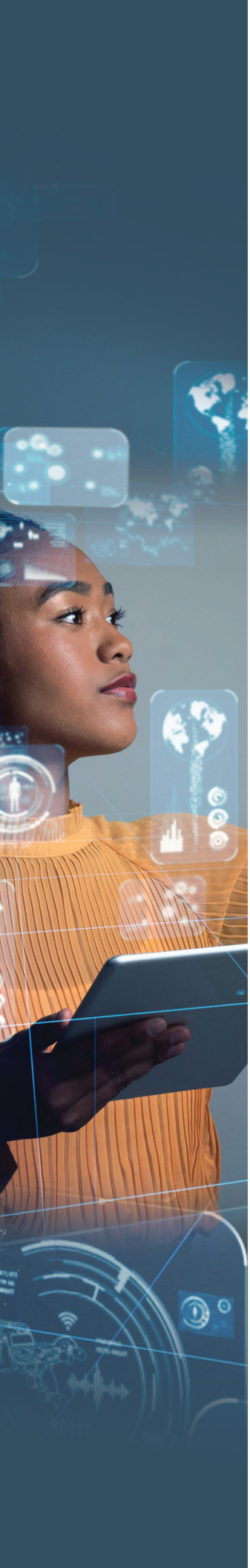
3 **Education leaders must respond with a sense of urgency to expand access to learning experiences that engage all students—and particularly underrepresented learners—in computing.** Girls, students of color, economically disadvantaged students, and students with disabilities are underrepresented in computing-related learning experiences. Overcoming gender, race, economic, and geographic barriers is paramount for promoting diversity, equity, and inclusion in education and in the workforce. To support underrepresented learners, education leaders must remove structural barriers to participation, which range from stereotypes and implicit biases about who can participate, to school schedules and teacher expertise, to inadequate network bandwidth, transportation, and costs.

4 **Authentic STEM learning experiences may increase participation, interest, and competencies in computing.** Authentic learning experiences reflect both professional practice—using skills such as problem solving, creation, experimentation, and inquiry—and personally and culturally meaningful activities. Developing computing competencies requires multiple authentic learning experiences over time: No single coding program or even computer science course is sufficient. Sustained engagement in computing experiences fosters students' personal "computing identity," which is critical to sustaining their interest, sense of belonging, and persistence in developing skills.

5 **Purposeful, concerted, multi-sector action is the best way to nurture all students' participation, interest, and competencies in computing.** An ecosystems approach recognizes that both schools and many other local and national organizations can play vital roles in developing computing competencies. Education leaders can network, collaborate, and forge partnerships with leaders of organizations and online platforms that provide out-of-school learning opportunities to mutually reinforce their offerings for students. Engaging a wide group of stakeholders, including education policymakers and the business and philanthropic communities, will help expand access.

Seven Steps to Take Now

1. Incorporate personally and professionally authentic computing experiences into existing K–12 standards, curricula and instruction; career and technical education; and afterschool programs. Prioritize the integration of robust opportunities to learning computing into existing elementary and middle school classes. Create coherent pathways into computing.
2. Take stock of facilities and learning spaces, technology and materials, internet bandwidth and electrical power capacity. Ensure that all students have access to an infrastructure capable of supporting authentic STEM learning experiences.
3. Prioritize access to authentic STEM learning experiences for underrepresented students—and provide wraparound support to help them succeed.
4. Provide teachers with sustained, long-term professional development to build their knowledge, competencies, and confidence to teach computing.
5. Network, collaborate, and partner with schools and other public and private organizations that provide out-of-school learning experiences to students.
6. Engage the business and philanthropic communities to support learning programs that develop computing competencies.
7. Design, implement, and evaluate the impact of new programs on learner interest, computing-related competencies, and subsequent choices to engage in computing activities.



Meet Hermione

An AP Course, Internships, and Mentors Lead to a Career Pursuit

Hermione grew up in a family that did not own a computer. She had no exposure to computer science until her sophomore year in high school. Working in the field of computer science had never crossed her mind. Now, after life-altering computer learning experiences in her school and district, she's a college student aspiring to a career that combines computer science and statistics.

As a Black woman, Hermione fits the demographic of students who are disproportionately underrepresented in computing education and careers. But an AP Computer Science course, the Beauty and Joy of Computing, became a turning point in her life. "The school put me in the class," she told the National Academies Committee on the Role of Authentic STEM Learning Experiences in Developing Interest in Competencies for Computing. "I had no choice and tried to get out of it. At first, I hated it. I didn't understand it. But I had a fabulous teacher, and I fell in love with it."

The following summer, her district's computer science internship program offered her a paid internship, which provided 60 hours of on-the-job tech experience and career preparation through a local university. She recalled the internship as transformative, exposing her to careers in computing that she didn't know existed and, notably, to an excellent mentor—a Black man who prepared her for what she would experience in the field of computing.

This first summer internship led to a second one with her district's CSforAll initiative team, where Hermione learned more about the education side of the industry. She worked with district staff who design and implement computer science learning experiences and attended many of the district's professional development offerings for teachers. She met industry professionals, including software engineers, who "blew my mind talking about what they do and how much they love it."

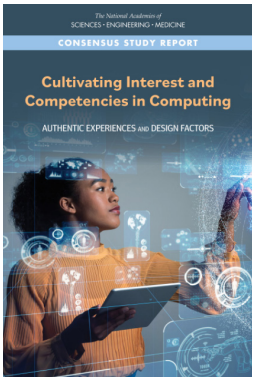
Hermione credits district educators, several of whom are women, Black, and Latinx, as a constant source of motivation and encouragement to stay in the field. To this day, these role models and mentors continue to check in on her and invite her to summer professional development sessions.

Hermione's career goal now is more focused. She wants to "take data and tell a story with it," perhaps in the fast-growing field of biocomputing. Although her summer internship after her sophomore year in college was cancelled due to COVID-19, she persisted and pivoted to an online bootcamp course to learn blockchain in C.

Learn More

Read the report highlights and the full report online, download a free PDF, or order the paperback publication today.

Cultivating Interest and Competencies in Computing: Authentic Experiences and Design Factors (2021)



This highlight is one in a series prepared by the Board on Science Education based on the report *Cultivating Interest and Competencies in Computing: Authentic Experiences and Design Factors* (2021). The study was sponsored by Google and the Grable Foundation. Any findings, conclusions, or recommendations expressed in this publication are those of the study committee and do not necessarily reflect those of the sponsors.

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