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THE COMPUTING IMPERATIVE:

Building America's Talent Engine in the Age of AI

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Disclaimer

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FOREWORD

America stands at an inflection point. Computing is no longer a narrow skill set reserved for technologists. It's the new basic literacy that underpins every industry and community and enables economic mobility. To remain globally competitive and expand opportunity for all, we must meet this reality with the urgency it demands.

I've seen what's possible when students experience rigorous, project-based computer science education along with mentorship and industry-aligned career pathways. Through CodePath's work across almost a thousand campuses, we've watched students (primarily low-income and first-generation college students) who might otherwise be overlooked start new technology companies and become top-performing engineers at leading organizations. These students transform their own trajectories and fuel the innovation and leadership our economy needs.

I've also seen the cost of inaction. Each year, outdated, fragmented education systems leave behind millions of talented young people. Every one represents a missed opportunity—countless possible innovators our nation can't afford to lose.

This report makes it clear that the challenge is national in scope and the solutions must be collective. Philanthropists, industry leaders, policymakers, and educators all must act to rewire education and workforce systems for an AI-driven world. That means creating new and further-reaching standards in K–12 computing education, reinventing higher education to evolve at the speed of industry and hardwiring lifelong learning into workforce development. It also means building a talent engine that reflects the full breadth of America, ensuring every community has the chance to contribute to and benefit from the innovations that will shape our future.

The Milken Institute's research provides both a sobering reminder and a hopeful road map. The choices we make today will determine whether the US simply adapts to technological disruption or leads it. For those with the resources to shape the future, this is an opportunity and an obligation. The American Dream and America's competitiveness both hang in the balance. The time to act is now.

Michael Ellison

Cofounder and CEO

CodePath

EXECUTIVE SUMMARY

As AI rapidly transforms every sector of the economy, computing is clearly no longer optional. Every industry, from health care to manufacturing to finance, relies on technology and digital talent. Global competition is accelerating. America's ability to compete, innovate, and expand opportunity now hinges on treating computing as a new basic literacy—just as essential as reading, writing, and arithmetic.

We must rewire our education system around this reality. From preschool to lifelong learning, the US must reimagine how we prepare learners for a world where every job, every community, and every sector requires computing and AI skills. Integrating rigorous and evolving computing skills into every stage of learning will sustain US leadership through rapid global shifts, expand economic mobility, and equip all Americans to shape the future.

America's K–12 schools often treat computer science (CS) education as an elective. Instead, CS must be a rigorous foundation for every student. Every school must have future-ready curricula, digitally fluent teachers, and the resources to deliver computing education at scale. When we fail to provide that access, we exclude the "lost Einsteins"—the innovators, entrepreneurs, and problem-solvers who could drive the next era of American prosperity but might never get the chance.[1]

Higher education must also transform urgently. The current model—rigid degree structures, outdated incentives, and narrow credentialing—no longer meets the needs of students or employers. To counter diminishing public trust and growing doubts of the value of a college degree, universities must build stronger partnerships, weave computational thinking across disciplines, and provide lifelong learning opportunities. Liberal arts must also be tech-infused and cultivate the critical thinking, creativity, and human-machine fluency required to strengthen the US workforce.

America has not made progress at the speed or scale required to compete globally. In November 2024, the Milken Institute partnered with CodePath to examine how CS education and careers can advance economic mobility and strengthen the nation. The Milken Institute conducted a literature review, interviewed over 40 experts, and participated in several convenings with experts in education, workforce, AI, entrepreneurship, and global competitiveness.

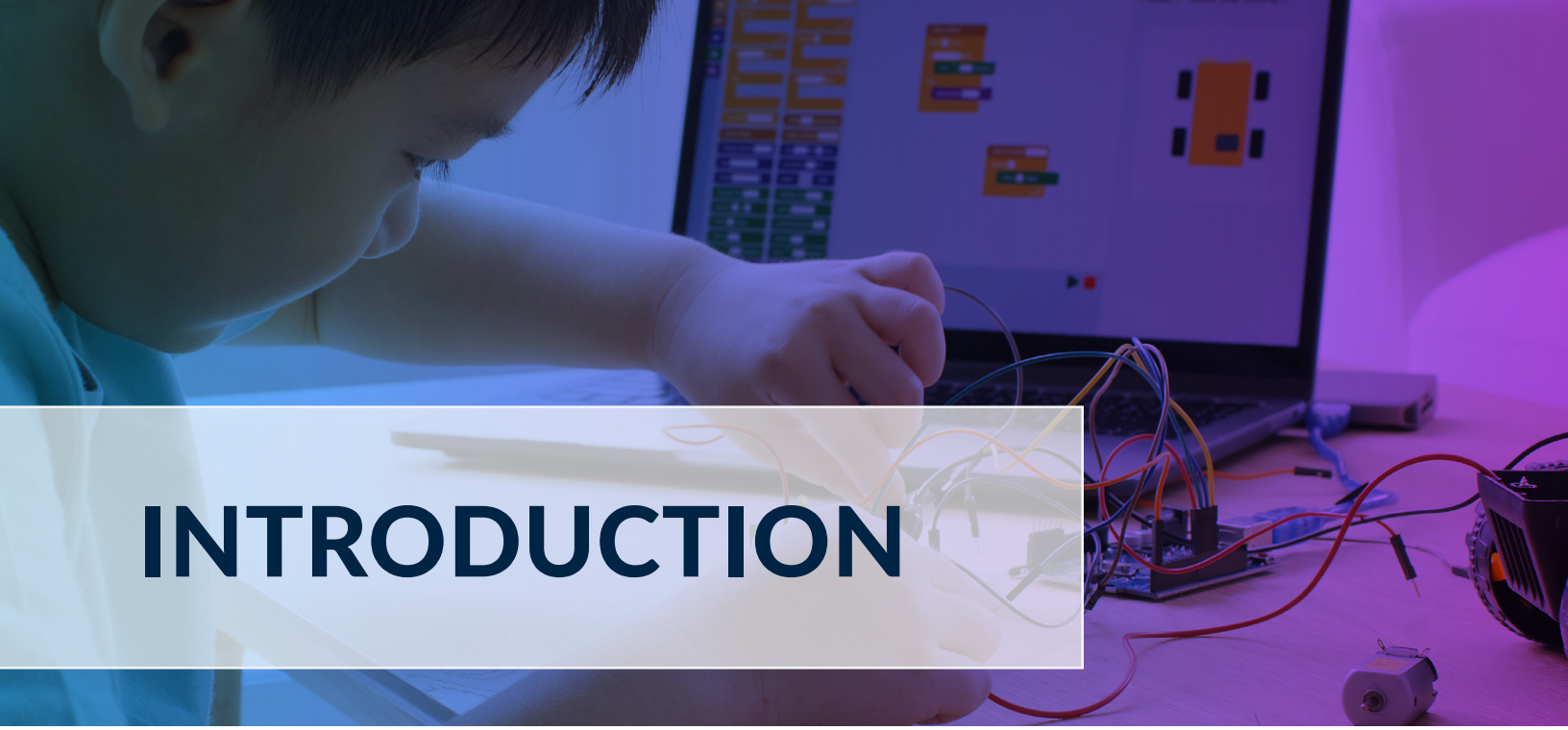
We found that US systems remain fragmented, unequal, and too slow to adapt as AI reshapes education and work. This challenge calls for a new national imperative: a complete and holistic rewiring of education and workforce systems, from preschool through lifelong learning. This will strengthen the nation's ongoing resilience and provide economic opportunities for all Americans.

Strategic deployment of philanthropic and impact capital can scale what works, test bold new models, and align education with a dynamic future economy. Investments can catalyze solutions by focusing on the following four recommendations:

1. **Make computing and AI the new basic literacy.** CS education is critical to opportunity—especially in the face of emerging AI. Funders can help scale rigorous K–12 computing education through modernized curricula, innovative teaching models, and digital fluency for every student. Education systems must teach dynamic computing skills alongside ethical reasoning and human-centered problem-solving.
2. **Reinvent higher education for the AI+ era.** Today's degree system is too rigid for tomorrow's economy. Targeted funding could help universities embed computational fluency across all disciplines while strengthening the role of the humanities and other liberal arts in preparing graduates to navigate human-machine interactions responsibly with technical expertise and creative capacity.
3. **Hardwire lifelong learning into the future of work.** The half-life of skills is shortening. Lifelong learning must become the norm. Funders can catalyze an upskilling and reskilling market by investing in portable credentials, open-access and low-cost opportunities, scalable platforms, and models that serve mid-career workers and communities most at risk of disruption.
4. **Build America's talent engine for global competitiveness.** Global competitiveness starts with a strong workforce. To bolster workforce resilience, philanthropy and impact capital can incentivize employers, universities, policymakers, and communities to form powerful regional talent hubs and cultivate tech innovation to position the US to outpace global competitors and expand economic mobility.

Together, these steps can unlock economic mobility for millions of Americans and secure US leadership in a tech-driven world. The future of the American Dream is at stake. Funders, educators, and employers must rewire the nation's talent engine, ensuring that computing talent is matched by human creativity, ethical grounding, and entrepreneurial drive. By pairing technical fluency with adaptability, critical thinking, and imaginative problem-solving, we can equip every learner to lead in the future economy. Our choices now will determine whether America simply adapts to the future—or shapes it.

For more information, please visit:
https://milkeninstitute.org/philanthropy/environmental-and-social-innovation.



INTRODUCTION

Computing is the foundation of the future workforce and the cornerstone of national competitiveness and leadership.

America's ability to compete globally, drive innovation, and expand economic opportunity depends on fully embracing computing and AI as a new basic literacy, reinventing higher education, and prioritizing lifelong learning. Our current education and workforce systems have not caught up to this challenge. Across K–12, computing is typically an elective rather than a core literacy. Higher education largely remains too rigid, often disconnected from the rapidly evolving demands of the future workforce. Lifelong learning, essential for keeping pace with rapid technological change, is still the exception rather than the norm.

Meanwhile, AI breakthroughs and intensifying global competition make systemic change not just necessary but urgent. As we move into the AI+ era, in which AI will be integrated across all industries and sectors, we must ensure all Americans have both technical and durable skills for using AI judiciously and to maximize its potential.

In November 2024, the Milken Institute partnered with CodePath to examine how CS education and careers can advance economic mobility and strengthen the US workforce. The Milken Institute consulted a broad cross-section of leaders and organizations. We conducted more than 40 private interviews and participated in events ranging from small workshops to large expos. We gained insights from investors, major corporations, large technology companies, philanthropic organizations, independent scholars, industry leaders, government entities, start-ups, established nonprofits, and public and private institutions across the education system and the country. We also held interviews and focus groups with peer experts and undergraduate interns within the Milken Institute.

We conducted all interviews under the Chatham House Rule, meaning that comments in this report are not attributed to specific sources. The project team also reviewed relevant literature, including academic journals, news articles, and online forums. The team conducted the research with strategic foresight analysis to generate the recommendations provided in this report.

This report explores how the US can rewire its education and workforce systems to make computing a foundation of opportunity for all. Grounded in research, expert interviews, and analysis of key stakeholders and funding trends, this report identifies high-level strategies to transform the ecosystem. Philanthropic and impact capital can catalyze this change.

This report is a call to action—backed by research and grounded in urgency—to enact bold solutions that center the future of the American Dream and all those striving to achieve it. In November 2025, the Milken Institute convened experts, funders, and industry leaders for an Innovation Forum to define the concrete steps needed to turn these recommendations into action.

COMPUTING CAREERS AND ECONOMIC MOBILITY

To expand opportunities domestically and sustain leadership in the global economy, the US must cultivate a workforce with strong, durable skills and computing expertise. But outdated education and workforce systems hinder us from prioritizing and scaling innovation in learning.

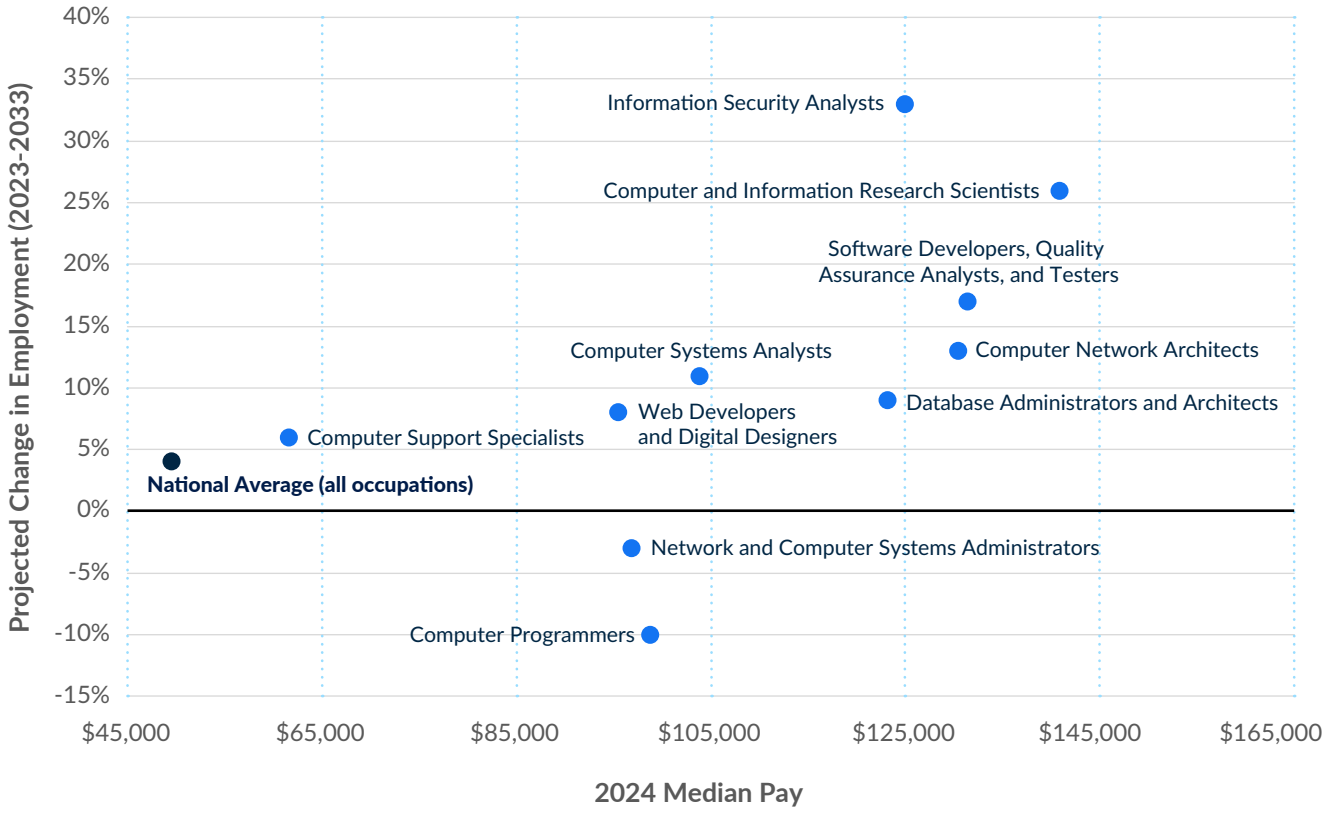
Treating CS as only a standalone, specialized discipline is a view of the past. We must teach computing skills alongside durable skills such as communication, creativity, collaboration, and critical thinking—traits that determine who advances in the labor market and which economies lead in innovation. We must ensure every learner has the opportunity to build the interdisciplinary skills they need to advance and adapt in the current and future workforce. This will secure individual economic mobility and ensure the US remains competitive in global markets.

Computing careers—and almost every other career—see new opportunities and new challenges due to AI's rapid development and adoption. According to the Bureau of Labor Statistics (BLS), computer and information technology occupations are expected to have some of the fastest growth in the US. These computing-related occupations currently have a high median wage ($105,990), with a projected growth rate of more than 30 percent and more than 400,000 new jobs expected between 2023 and 2033.[2] Median wages for every computer and information technology occupation are higher than the national average of $49,500.[3] Subspecialties, however, exhibit significant disparities in wages and growth rates, as shown in Figure 1. For example, computer support specialists have only slightly higher-than-average growth and median wages.

Computer programming jobs, as defined by BLS, are projected to decrease by 10 percent between 2023 and 2033. In the same time frame, software developer jobs are expected to grow by 15 percent.

According to another analysis, computer programming jobs have already dropped by over 25 percent between 2023 and 2025, outpacing BLS's 2023 projection.[4] Even so, some industry professionals recognize little functional difference between computer programming and software development, so this change may represent a shift in responsibilities or titles rather than core skills.

Figure 1: Wages and Projected Growth for CS Careers from 2023 to 2033



Note: Occupation descriptions can be found in the appendix.

Source: Milken Institute (2025), based on BLS data

Other specialties, such as data science and information security, are also expected to continue growing (Figure 1). But even some cybersecurity companies are shifting their hiring due to AI capabilities.[5] Between new roles created and old roles downsized by AI's expansion, it is difficult to project the net employment change for computing jobs.

However, tech and non-tech jobs continue to value strong computing competencies. All AI-based technologies—including machine learning, deep learning, natural language processing, large language models, and generative AI—require advanced computing skills to build.[6] Integrating computing skill development across all education levels ensures every learner can maximize their education and remain competitive in an evolving talent market.

AI AGENTS AND THE FUTURE OF SOFTWARE ENGINEERING

Now that AI can generate code, there is some debate as to whether it is still worth learning to code at all. Agentic coding tools are becoming more powerful, with AI moving from writing short code snippets to integrating dynamically throughout entire codebases.

As of September 2025, Anthropic's Claude Sonnet 4.5 can perform complex tasks for up to 30 hours.[7] Anthropic's cofounder described the model as "more of a colleague," while competitor OpenAI describes its GPT-5-Codex model as a "teammate for your most ambitious projects."[8] Beyond simple code generation, multiple AI agents can now work together in a "swarm" to plan, test, and debug iteratively.[9]

Agentic coding has also caught the attention of investors and tech giants. In July 2025, Cognition, the start-up behind the Devin coding agent, acquired Windsurf amid fierce competition with industry leaders such as Google and OpenAI.[10] In September 2025, the company raised $400 million in venture capital funding, raising its valuation to $10.2 billion within one year.[11]

The appeal of coding with AI is undeniable. A recent survey found that 97 percent of software developers and engineers already use AI tools at work, regardless of company policy, and over 90 percent say AI coding tools improved their code's quality.[12] But many experts interviewed for this report emphasized the importance of understanding coding foundations when coding with AI agents—just as schools did not stop teaching arithmetic when the calculator was invented. Software engineers working with AI will need coding expertise to understand AI-generated code, evaluate it for correctness, and debug as needed.

The efficiency coding agents offer can free a software engineer to spend more time on building better systems. Computer literacy should therefore incorporate creative and systems thinking skills. It should also include management skills for supervising human engineers alongside coding agents.

PRIORITIZING US COMPETITIVENESS

The global race for AI has emphasized the importance of computing education and training.

Federal policy continues to prioritize technology and workforce development as national priorities, even amid notable tactical shifts. Multiple executive branch actions, such as the executive order "Advancing Artificial Intelligence Education for American Youth" and *America's AI Action Plan*, released in 2025, have placed an unequivocal emphasis on AI as the key to economic competitiveness and national security.[13] The sections below outline how global competition is changing, raising the stakes for computing education and tech workforce development.

Shifting Funding and Talent Landscape

The CHIPS and Science Act, passed in 2022, made major investments in workforce development and educational access, recognizing them as strategic priorities.[14] But shifts in federal policy have created instability in education, workforce, and research funding. Much of the workforce development and education funding authorized by the CHIPS and Science Act was directed to the National Science Foundation (NSF). Since Congress established the NSF's Broader Impacts Review Criterion in 2010 and through its amendment in 2017, the NSF has considered global competitiveness and participation of women and underrepresented minorities under the criterion.[15]

However, many of the CHIPS and Science Act's programs were frozen in 2025, and President Trump has suggested repealing the act entirely.[16] As of April 2025, the NSF issued a statement clarifying that the Broader Impacts Review Criterion "must aim to create opportunities for all Americans everywhere" and that "projects with more narrow impact limited to subgroups of people based on protected class or characteristics do not

effectuate NSF priorities."[17] Experts interviewed by the Milken Institute expressed concern about funding cuts to technology, education, and workforce development programs focused on increasing representation. Such cuts could undermine the nation's goals for innovation and competitiveness, especially given research that demonstrates the benefits of diversifying the workforce.

Public-private partnerships have bolstered government efforts throughout the Obama, Biden, and both Trump administrations. Since 2016, billions in private capital have been committed, alongside federal initiatives, for technological priorities like AI; science, technology, engineering, and math (STEM) and CS education; semiconductor manufacturing; and data infrastructure.[18]

More recently, Trump administration officials advocated for "creatively allocating [US] public research and development dollars" and prioritizing strategic technologies.[19] They identified workforce productivity as a key to innovation and competitiveness.[20] Research institutions, education and training providers, and the private sector have responded to this call with new initiatives and investments focused on AI, science, and technology. For example, the Vision for American Science & Technology, launched in February 2025 and supported by philanthropy, highlights the need to invest in STEM education and workforce to strengthen US leadership.

Historically, American leadership in technology has been driven by a powerful combination of immigration and higher education, but shifting federal policy has raised new challenges in both areas. The US is already a "global productivity frontier" with advantages in computer programming and information technology.[21] However, more foreign-born employees work in computer and mathematical roles than US-born employees, suggesting that immigration drives significant productivity in this area.[22]

American degrees have long been a coveted US export, valued at over $40 billion per year.[23] Currently, most doctorate-level workers in CS or mathematics are foreign-born, and an even higher percentage of temporary visa holders in science and engineering intend to stay in the US.[24] The US also maintains an advantage in attracting top researchers for postgraduate training and employment in key AI fields like advanced data analytics, machine learning, and natural language processing.[25]

However, the high proportion of foreign-born STEM workers has been cited as a rationale for proposed federal restrictions on the H-1B visa program.[26] With visa sponsorship becoming increasingly difficult for international students to obtain and deportation under rigid new policies becoming a growing fear, even for students with visas, American universities could start to lose this market.[27]

Recent changes in federal research funding and policy have prompted some US scientists to explore opportunities abroad. One recent poll suggested that 75 percent of responding scientists were looking for employment opportunities in Europe and Canada in early 2025.[28] Universities in other countries, such as France, Germany, and Belgium, set up programs specifically to recruit American STEM researchers.[29] Meanwhile, China was actively recruiting foreign-born researchers to tech research roles with competitive visa programs, job stability, and attractive compensation.[30]

American degrees have long been a coveted US export, valued at over **$40 billion per year.**

Stricter immigration rules or shifts in federal research priorities could reduce the flow of international students, foreign-born researchers, and US-educated talent into the country, potentially benefiting global competitors. Maintaining a robust, highly skilled American workforce is therefore essential to sustaining innovation, scientific leadership, and economic competitiveness in a rapidly evolving global landscape.

Increasing Global Competition

In the context of advanced technology, China is the US's foremost competitor. China is investing heavily in advanced technology research and development and has expanded its investment in public education as a share of GDP.[31] China mandates interdisciplinary STEM learning at the high school level, giving its students an early competitive advantage in tech compared to the US and other peers. In 2017, the Chinese government introduced its "New Generation Artificial Intelligence Development Plan," a comprehensive national agenda for AI education.[32]

Some experts have discounted China as a "fast follower" that poses no threat to US leadership in developing never-before-seen innovations.[33] Some go so far as to argue that "China can't innovate."[34] The results tell a different story. As of 2023, China was leading in 37 out of 44 critical technologies tracked by the Australian Strategic Policy Institute, indicating strong momentum as a global competitor.[35]

Competition with China for advanced technologies has been an economic driver for the US. The US private sector invested $109.1 billion in AI alone in 2024, compared to $9.3 billion invested by Chinese businesses.[36]

Computing innovation and competitiveness present a symbiotic opportunity for the US government and the US private sector. American businesses could profit considerably from a national tech innovation agenda, and they will be crucial to the US dominating the global tech race. Large-scale events with public-private sponsorship, such as the Special Competitive Studies Project's AI+ Expo on National Competitiveness and the Winning the AI Race summit hosted by the All-In Podcast and the Hill & Valley Forum, demonstrate this alignment.[37] Recent federal priorities have emphasized partnering with private-sector leaders to advance tech competitiveness.

Competition for computing innovation is not limited to the US and China. European competitiveness has become particularly relevant in the context of shifting US trade policies, the Russia-Ukraine war, and other macroeconomic factors. Former European Central Bank President Mario Draghi's September 2024 report on European competitiveness continues to resonate in policy circles.[38] The Draghi report identifies computing and AI as key factors for competitiveness, as well as associated technologies such as cloud infrastructure and high-speed broadband. Recognizing American and Chinese leadership in these areas, the report identifies opportunities for Europe to build on its own market shares.

Europe is still behind the US and China in productivity, patents, and companies in the tech sector. To address this, the Milken Institute has recently launched its European Competitiveness Initiative, which highlights many of the same barriers and opportunities as the US. Such opportunities include widening capital access, unlocking a diverse talent pool's potential, and using place-based initiatives.[39]

As competition for AI and advanced technology rages among the US, China, and Europe, many other regions vie for human and financial capital. The emergence of high-tech hubs in the Middle East, Latin America, Asia, and Africa, combined with rising geopolitical tensions, could attract companies and workers seeking new opportunities. Countries are tailoring strategies to their own strengths—such as specialized regulatory frameworks and investment strategies in the United Arab Emirates, Qatar, and Saudi Arabia; fast-growing youth populations in Nigeria and South Africa; a national commitment to upskilling in Singapore; and manufacturing prowess in Mexico.[40]

Emerging and developing economies in Latin America and the Caribbean have begun to eclipse their counterparts in Asia in foreign direct investment, in part by leveraging advantages in workforce talent.[41] In Latin America, the information technology sector is also driving mergers and acquisitions activity, a key draw for foreign investment.[42] As American tech companies sell to global markets and compete for global talent, the US must remain attentive to these regional developments.

Countries around the world are racing to capture the potential of AI and other advanced technology for economic and strategic competitiveness. Over the next decade, global competitiveness will favor the countries that can align their national priorities, education and workforce systems, and economic engines with advanced technologies. By investing in developing computing skills for all learners and workers, the US can leverage its workforce to remain a global leader in innovation and economic strength.

STAYING AHEAD OF THE NEXT FRONTIERS

Generative AI will not be the last technology to cause widespread upheaval in the computing education and workforce ecosystem. In fact, AI is accelerating tech innovation in many areas, and advanced technologies will likely arrive more quickly than anticipated as a result. Quantum computing, computational biology, living intelligence, and artificial general intelligence may seem nascent now, but they may be only a breakthrough or two away from the mainstream. They represent the next frontiers that will redefine education and the workforce and present new opportunities for economic mobility and national competitiveness.

As the US and other countries go all in on AI literacy and infrastructure, they must build flexible education and workforce systems that can adapt to these new technologies as they emerge. Education and workforce development must also include ethics and the humanities to ensure that any future technologies properly reflect and strengthen human values.

Quantum computing applies principles of quantum mechanics to solve highly complex problems that are beyond the capacity of even modern supercomputers.[43] The transformative potential of quantum computing is so alluring that companies from start-ups to Big Tech, as well as state governments and federal agencies, invest heavily in quantum infrastructure and talent recruitment.[44] While industry demands for quantum computing skills remain unclear, foundational capabilities in CS, data science, and coding will remain critical pathways into the field.[45]

Computational biology harnesses advanced computing to quickly process and use massive amounts of biological data. This interdisciplinary field taps into biology, CS, informatics, mathematics, and statistics.[46] Integrating AI with computational biology presents even greater opportunities for breakthrough research and job creation across sectors. Use cases such as personalized medicine, disease prevention, precision agriculture, natural resource management, and disaster preparedness demonstrate the immense potential for this discipline to advance any field using big data in the age of AI.[47]

Living intelligence refers to the convergence of AI, advanced sensors, and bioengineering to create digital systems that can understand and interact with the physical world.[48] Living intelligence implies not just analyzing biological data but creating new ways to encode biological principles into computers and use biological systems for computing itself. This frontier has significant potential to create or advance technology in many areas and requires new workforce strategies.[49]

Artificial general intelligence does not yet exist, and its arrival could be decades or centuries away.[50] But advances like quantum computing could achieve this milestone in the less-distant future by accelerating AI development. Even without a quantum breakthrough, some believe artificial general intelligence could arrive within the next two to five years. While many see this scenario as far-fetched, we must acknowledge and prepare for this possibility, however slim. In any case, education in some form will likely continue to exist as a fundamental way to pass knowledge from one generation to the next.

EDUCATION AND WORKFORCE DEVELOPMENT

Despite more than a decade of numerous national policies and significant funding to increase CS skills across the US, most US students still lack the deep understanding and technical skills to excel in the future workforce.

There is a growing urgency to ensure that K–12 students receive early exposure and training in computational thinking, digital fluency, and AI literacy. To avoid losing a generation of potential tech talent, higher education needs immediate reform. And the current workforce needs immediate upskilling and reskilling.

To maximize America's future talent engine, we must invest in innovative approaches to next-generation teacher training, curricula, mentoring, upskilling, and reskilling models that focus on human-machine interactions. Such education is needed at all levels—from preschool through lifelong learning.

K–12 Education

K–12 education underpins the US educational system. Students start forming their identities and interests at a young age. K–12 education is often the first place they encounter STEM and computing topics. As an AI-driven workforce demands specialized skills earlier and earlier, K–12 has become an even more crucial intervention point. By building future-ready curricula and support systems, we can address gaps early and support student flourishing.

Redesigning Curricula

Supporting the next generation's computing skills requires coordinated efforts to develop, pilot, and scale new computing curricula and education models. Schools must seek intuitive K–12 curricula that pair AI literacy with critical thinking and decision-making skills—for example, data interpretation, logic, reasoning, synthesis, systems thinking, and forecasting. Any such initiative can boost short-term student success and long-term career success. Curricula that integrate AI literacy across disciplines can prepare students for any career path.

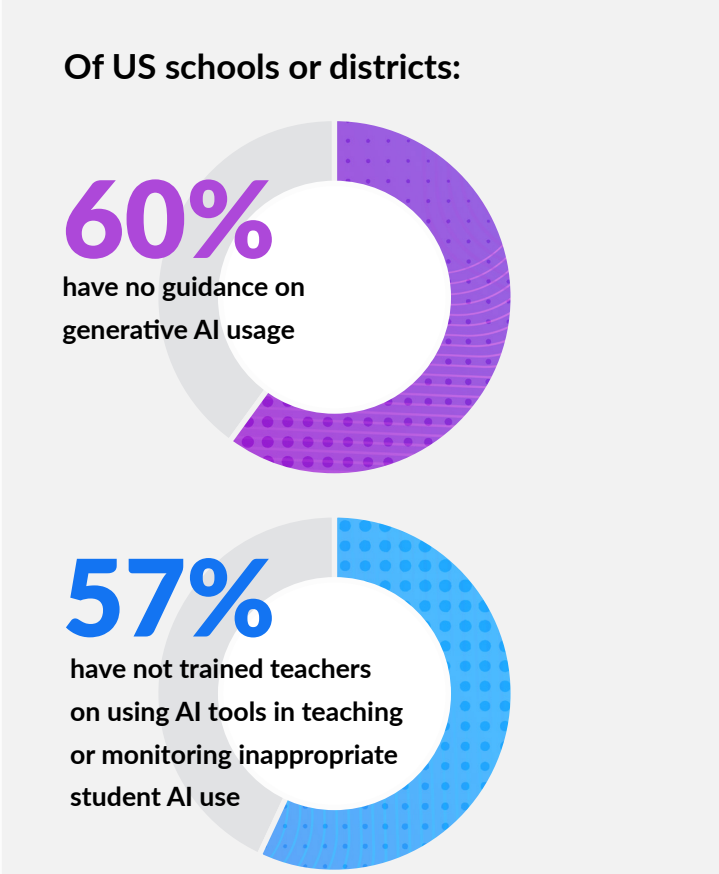
It is challenging to coordinate learning and teaching models across the nearly 100,000 US public K–12 schools.[51] The US initially based its CS education standards on the Next Generation Science Standards, introduced in 2013.[52] This framework included seven core computing practices, including computational thinking, collaborating on computing tasks, and communicating about computing.

Despite these efforts, a significant portion of K-12 schools still do not offer comprehensive computing curricula. As of 2024, only 60 percent of public high schools offered a foundational CS course, and seven states did not have CS standards.[53] As a result, students across the US leave K–12 systems with highly variable computing and AI skills, limiting their readiness for postsecondary education, the future workforce, and opportunities in an increasingly competitive digital economy.

Today, inconsistent adoption of AI in K–12 classrooms creates additional computing education disparities (Figure 2). As of 2025, 60 percent of US schools or districts, many of them Title I and rural schools, have not provided any guidance on generative AI usage.[54] Another 57 percent have not yet trained teachers on using AI tools in teaching or monitoring inappropriate student AI use.[55]

In recent years, experts in K–12 education and AI use have advised schools and policymakers to address these gaps with a focus on: 1) developmentally appropriate instruction in AI; 2) ethical and critical use of AI tools; 3) pairing human cognition with AI use; and 4) learning through human interaction rather than screens alone.[56] These calls to standardize AI education nationwide join a growing global chorus calling for AI curricula and teacher training.[57]

Figure 2: Computing Education Disparities in US K–12 Classrooms



Source: EDSAFE AI Alliance (2025)

Supporting Teachers

Access to K–12 CS education also depends on the availability of qualified CS teachers. In the 2024–2025 school year, about 4 percent of CS teaching positions were vacant—slightly higher than the national average of 3 percent across all teaching positions.[58] Currently, only 17 percent of CS teachers have CS degrees.[59] But teachers with a bachelor's degree in CS are more likely to remain committed and feel a sense of belonging in the profession.[60]

Supporting CS teachers may be a straightforward way to expand access to CS training.[61] For example, by sponsoring scholarships for students who wish to attain CS degrees and become CS teachers, funders can create both individual career opportunities and systemic improvements in K–12 CS and AI education. Supplementing CS degree programs with teacher-training and certification programs—and perhaps even subsidizing new teacher salaries—can further ensure school districts across the country have well-trained and well-compensated CS teachers.

The Impact of Mentorship

Mentors and role models also influence a learner's journey, especially for students from underrepresented backgrounds. For younger students considering STEM careers, role models who share their lived experiences often spark sustained interest in STEM. Yet representation in CS fields and classrooms remains particularly low for women, students of color, and learners from rural areas and Indigenous communities. In interviews, experts emphasized that over time, the absence of relatable role models can diminish both motivation and persistence.

The data underscore this challenge: While nearly half (49 percent) of elementary school CS students are girls, participation drops to 44 percent by middle school, 33 percent by high school, and only about 20 percent by college graduation.[62] While there are some interventions designed to resolve these workforce disparities, the parity of CS students in elementary school compared to representation in college suggests that nurturing students' interest and engagement in CS from an early age may have an outsized impact.

Expanding access to role models, mentoring, and rigorous training strengthens the workforce pipeline and US competitiveness. Opening pathways for more students, especially those historically underrepresented in CS, means cultivating a more expansive, creative, and resilient workforce that reflects American communities. As US immigration pathways change and international competition for top talent intensifies, America cannot afford to leave potential innovators behind. Now more than ever, ensuring US students have encouragement and training from mentors is critical both for individual economic mobility and the nation's global economic leadership.

Higher Education

For many, the decision of whether and where to attend college has lifelong implications. Higher education institutions—from community and technical colleges to four-year universities—are hubs of innovation all over the country. They are essential to meeting learners' evolving needs and preparing them to contribute to the workforce and society.

Value of a College Degree

A college degree remains one of the strongest predictors of economic mobility in the United States.[63] But it is not a guarantee. In the next five years, many positions across industries are still expected to require a bachelor's degree.[64] But rising numbers of unemployed college graduates—including those with bachelor's degrees in CS—have diminished trust in the ability of colleges and universities to adequately prepare students for the workforce.[65]

American higher education institutions face public pressure to reexamine and justify their structure, cost, and value to society. In the US, many students who begin college never finish, leaving them with debt but no credential.[66] Meanwhile, other countries race ahead to build a diversified talent pipeline through technical training and specialized education strategies, strengthening their global competitiveness.[67]

A trend in the US toward "skills-based hiring" has attempted to dislodge degrees as the benchmark for workforce readiness.[68] Initiatives like the Tear the Paper Ceiling campaign, which encourages employers to hire based on skills, regardless of degree earned, have drawn attention to unnecessary degree requirements and their role in excluding non-college-educated professionals from career pathways.

Despite these pressures, obtaining a CS undergraduate degree has distinct advantages. One is that some employers may still prioritize formal education and prefer applicants with college or university degrees, especially when paired with durable skills or microcredentials.[69] Another advantage is that undergraduate education can lead to a graduate degree in CS, which is often preferred or even required for more advanced or senior tech positions. Many computer and information research scientist positions typically require master's degrees at entry level.[70] Doctoral degrees may be required to advance to mid- and senior-level positions focused on advanced CS and AI research.

Integrating Liberal Arts with Computational Fluency

To remain relevant and competitive, higher education needs to embed computational fluency across all disciplines. This approach must include training from the humanities and other liberal arts that prepares students to understand their own unique capacities as humans and to use AI tools effectively and judiciously. This includes durable skills such as critical thinking, creative problem-solving, and communication—skills that help design better AI prompts and scrutinize AI-generated content. Humanities also foster the ethics,

philosophy, history, and social awareness necessary to understand the source material and full context of AI-generated content and the potential outcomes and consequences of AI outputs. The goal is to let AI enhance thinking rather than replace it.

Taking a liberal arts approach to computing education prepares students for much more than using AI tools. When we asked experts about essential skills for current and future job markets, almost all mentioned durable skills. Currently, 8 of the top 10 skills most requested by employers are durable skills.[71] Over three-quarters of job descriptions list at least one durable skill, and nearly half seek three or more.[72]

Incorporating strong decision-making, agency, self-awareness, and other life skills with computational fluency will give students the tools and confidence to navigate any career or life path. Higher education must cultivate and reinforce these skills to ensure graduates can thrive in a digital, tech-driven world.

Bridging to Other Pathways

Fulfilling the mission of US higher education will require operating in an ecosystem rather than in isolation. Higher education institutions must therefore open multiple rigorous, affordable, and flexible pathways into their programs and from their programs into the workforce.

Building stronger bridges between community colleges and four-year institutions, for example, can offer a more affordable and accessible entry point into the computing and AI ecosystems. Community colleges often do not have the same resources, opportunities, advising capacity, or industry connections as major universities. About 80 percent of community college students want to transfer to four-year institutions.[73] But lack of good guidance about logistical issues, such as whether schools will accept course credits or provide financial packages, can create additional barriers to a student's academic journey, according to experts interviewed and other sources.[74] The advising ratio at community colleges can exceed a thousand students per advisor.[75] Reducing that ratio considerably could change students' lives.

Another way to add value to higher degree programs is to build strong pathways to industry jobs. Collaborations between colleges or universities and industry can help ensure that graduation requirements align with labor market needs. According to experts interviewed for this report, funders can help create pathways through strategic initiatives such as creating paid internship opportunities; embedding industry work experience into course curricula; upgrading technology infrastructure; sponsoring local professional development and job search events; and funding the hiring of CS instructors and advisors to ensure that students are able to gain in-demand CS and AI skills and navigate recruitment. By bridging gaps between education and employment, funders can help students pursue more accessible and equitable pathways into tech careers. This fosters both individual empowerment and a diverse, resilient, and innovative tech workforce.

Currently, **8 of the top 10 skills** most requested by employers are **durable** skills.

Workforce Development

Economic mobility and US competitiveness now hinge on how quickly and effectively America can adapt its workforce to the AI-driven economy. Generative AI is transforming jobs across every sector, disrupting traditional career paths, and creating demand for new, highly specialized skills.

The Need for Upskilling and Reskilling

The emergence of AI deepens the need for high-quality upskilling and reskilling efforts for the workforce. As AI is integrated across sectors and the job market becomes more competitive, employers expect a higher level of technical competency even for entry-level roles. At the same time, with more employers using AI to automate lower-skill functions, current workers need near-constant upskilling to stay ahead. Employers benefit from upskilling in the form of workforce resilience, so they are incentivized to retain and upskill their workers by building training programs or partnering with external institutions. But in some subsectors, AI will displace entire categories of workers, who will need reskilling to move to new industries.

Policy reforms are beginning to expand access to workforce training. The One Big Beautiful Bill Act, for example, extended Pell Grant eligibility to short-term programs for the first time. These reforms changed the number of credit hours required for federal financial aid through the Pell program, which previously required at least 600 hours and 15 weeks of instruction.[76] This shift could significantly lower barriers for low-income learners to access quality computing-related programs in high-demand areas such as data science and cybersecurity. As rapid technological change demands continual reskilling and upskilling, these shorter, more flexible programs will broaden access to economic opportunity while ensuring the US has the talent base to compete globally.

Accelerating Apprenticeships

Apprenticeships have gained momentum as a practical, work-based learning model to help Americans enter the tech workforce. Unlike traditional CS degrees, which often focus on theoretical foundations over real-world applications, apprenticeships focus on applied skills directly relevant to specialized roles. Major tech employers, such as Oracle and IBM, have piloted apprenticeship programs to address the disconnect between formal education and the real-world needs of the tech sector.[77] Over the past decade, AI-related apprenticeships have grown 250 percent.[78]

Apprenticeships have also benefited from a recent surge in policy support. In 2024, the Biden administration promoted apprenticeships in several ways, including proposed rulemaking, an executive order, and new funding.[79] In 2025, the second Trump administration set a target of one million active registered apprenticeships.[80] To support this goal, the administration has begun to mobilize federal funding.[81] Apprenticeships are not yet widespread in the tech workforce, but targeted investments and program adjustments could help overcome the high set-up costs and complex registration requirements.[82]

Military apprenticeships can strengthen US competitiveness in AI-driven defense capacities. Current offerings focus on more basic computing functions.[83] For example, the US Military Apprenticeship Program, which sponsors the most computing apprenticeships overall, has historically focused on general computing and mathematics for less advanced computer operator roles.[84] But some regional military entities, such as the South Carolina National Guard, have started sponsoring AI-related apprenticeships.[85] The military could implement this model across its branches and affiliates to build and maintain capacities such as autonomous systems and response to cybersecurity threats.

Expanding Entrepreneurship

AI will likely benefit entrepreneurship. AI-assisted services can streamline many business operations, making it easier for entrepreneurs to start and manage their own companies. The US can especially benefit from this trend. The country is a long-time leader in innovation and high-tech entrepreneurship, largely due to its favorable regulatory and capital market environment, the attractiveness of its higher education institutions, and its advanced computing infrastructure. A recent analysis from Stanford's Venture Capital Initiative suggests that start-ups founded abroad benefit greatly from moving to the US to scale, and in return, the US entrepreneurial ecosystem benefits from foreign-born founders.[86]

For American entrepreneurs, AI's growth may mitigate the "lost Einsteins" effect, which estimates the proportion of individuals who could have developed new technologies if not hindered by socioeconomic factors.[87] Increasing the participation of underrepresented groups in innovation could quadruple the number of inventors in the US.[88] By lowering the barriers to entry for both US-born and foreign-born entrepreneurs, AI could result in a multiplier effect on American entrepreneurship.

Building a Representative Tech Workforce

Developing advanced, ethical tech for the US requires a workforce that reflects the American population and its diverse perspectives and experiences.[89] A diverse computing workforce can help reduce the risks of bias and racial profiling in AI-assisted tools, according to experts interviewed by the Milken Institute and other sources.[90] Studies also show that diverse teams outperform homogeneous ones.[91]

America does not yet have a representative tech workforce. In 2018, experts recognized a "leaky tech pipeline," identifying structural barriers in the tech ecosystem that limit retention and advancement of individuals from underrepresented groups.[92] The US has since made some progress—between 2015 and 2022, the proportion of Hispanic workers increased by around 40 percent, and the proportion of Black workers increased by around 20 percent. But barriers to access persist, and Black and Hispanic workers remain underrepresented in high tech compared to other sectors.

Since 2005, despite efforts to increase female participation in the sector, female representation in the high-tech workforce has remained stubbornly low at around 22 percent.[93] For both equal access to opportunity and for nationwide AI readiness, the US tech sector needs workforce development efforts that increase talent diversity.

RECOMMENDATIONS FOR IMPACT CAPITAL

We have a national imperative: a complete and holistic rewiring of education and workforce systems, from preschool through lifelong learning.

Strategically deploying philanthropic and impact capital can catalyze solutions—strengthening what works, testing bold new models, and aligning education with the demands of a dynamic future economy. At a time when philanthropic resources are increasingly strained, we must intervene strategically to strengthen computing education and workforce development. This section outlines opportunities for new and existing philanthropic funders, impact investors, and corporate entities to have an outsized impact.

RECOMMENDATION 1

Make Computing and AI the New Basic Literacy

CS is the infrastructure of opportunity, especially with the growth of AI. Past efforts to expand CS education have often focused too narrowly on the subject itself, rather than embedding computing skills across learning. It is time for a bolder approach: not just giving all students access to computing and AI education but integrating comprehensive computing and AI skills throughout every part of education.

Funders can accelerate this shift by underwriting the rapid scaling of rigorous K–12 CS programs—updating curricula and adopting innovative teaching models—to prepare every student for a tech-driven economy. This will take more than coding bootcamps or AI literacy frameworks. It demands sustained investment in the continuous cycle of development, implementation, and evaluation that education will need to keep up with constant technological change.

Every K–12 student deserves access to computing and AI education. That starts with investing in our teachers. Funders can help teachers integrate CS and AI across all subjects, providing the compensation, professional development, and wraparound support they need to innovate and confidently prepare the next generation.

Rather than replacing human teachers, AI tools can extend teacher capacity, freeing time for what matters most: connecting with students, nurturing core values, and igniting imagination. Students will need advanced computing and AI skills, but they will also need to learn ethical reasoning, collaboration, and human-centered problem-solving to thrive in a future where technology and society are inseparable.

RECOMMENDATION 2

Reinvent Higher Education for the AI+ Era

Today's degree system is too rigid for tomorrow's economy. Investments should accelerate stackable, work-aligned credentials and partnerships between academia and industry that produce graduates ready to lead with both technical expertise and creativity.

Funders should back universities that demonstrate the continued value of higher education by embedding computational fluency across all disciplines and providing workforce-ready skills. CS departments and research labs will continue to incubate top engineers. But to close the gap between theory and practice, these departments will need closer alignment with industry and flexible curriculum models. At the same time, strengthening the role of the humanities and other liberal arts can prepare students to navigate human-machine interactions responsibly.

Sponsoring industry residency programs for college professors can help academics learn cutting-edge methods they can pass on to their students. Bringing industry professionals into the classroom to design projects and provide feedback can also drive lasting engagement. Closing the gap with industry will revive hope in higher education's value by giving students something more than just a degree. It will give students the confidence they need to succeed in a future workforce that does not look like the past.

RECOMMENDATION 3

Hardwire Lifelong Learning into the Future of Work

The half-life of skills is shortening. Lifelong learning must become the norm, not the exception. It should combine constantly evolving technical mastery—from AI to cybersecurity to the next frontiers of computing—with durable human skills such as adaptability, critical thinking, and ethical judgment. Only by blending the two can workers remain competitive as technology advances.

Funders can catalyze a new market for upskilling and reskilling. They can invest in portable credentials, open-access and low-cost opportunities, platforms that scale quickly, and models that serve mid-career workers and communities most at risk of disruption. Measuring and tracking skills requires robust data systems, a common language for evaluation, and a shared commitment to lifelong learning between employers and employees.

Skills-based hiring may have become more popular, but employees need strong skills long after the job offer. We need skills-based promotion, skills-based compensation, and skills-based management. Only when employers encourage and incentivize workers to learn new skills through formal training and on-the-job experiences can businesses stay competitive. Driving capital toward companies and programs that prioritize reskilling and upskilling will lead to long-term gains for workers and for national competitiveness.

RECOMMENDATION 4

Build America's Talent Engine for Global Competitiveness

Global competitiveness starts with a strong workforce. To bolster workforce resilience, philanthropy and impact capital can incentivize employers, universities, policymakers, and communities in a given region to connect resources and establish pathways for students and workers. By supporting incubators that launch start-ups and degree programs with strong local internships and apprenticeships, these place-based collaborations can form active regional talent hubs. When these regional hubs connect with each other, they form an ecosystem that fuels national competitiveness.

Entrepreneurship should be central to this effort. Funders can foster entrepreneurship by cultivating computing literacy with creativity and ambition. With AI tools accelerating innovation, we can expect breakthroughs at a speed much faster than even the dot-com era. Training entrepreneurs to be effective and judicious innovators, ready to create or harness fit-for-purpose technology, will prepare them to contribute to competitiveness long term and power the next chapter of the American Dream.

Funders must prepare to back early-stage but high-potential models to help cultivate tech innovation across all ages and disciplines. Investing only in proven solutions, established institutions, and familiar regions risks slowing innovation and consolidating resources to the detriment of underserved communities. By giving new ideas and innovators an opportunity to flourish in the ecosystem, funders can position the US to outpace global competitors while expanding economic mobility at home.

CONCLUSION AND CALL TO ACTION

America stands on the threshold of transformation.

Global competition is intensifying, AI is reshaping every sector, and the half-life of skills is shortening. Economic mobility and national competitiveness will hinge on whether we equip Americans with both technical expertise and durable human skills for the AI-driven economy. America must act now to rewire education from preschool through lifelong learning to fully reflect this reality.

This report charts a path forward, but ideas alone will not suffice. By investing boldly now in skill-building, innovative education, and career pathways for all Americans, we can build a current and future workforce that is adaptable, creative, and globally competitive, laying the foundation for opportunity and leadership for generations to come.

APPENDIX

Bureau of Labor Statistics Occupation Descriptions[94]

JOB SUMMARY

- **Computer and information research scientists** design innovative uses for new and existing computing technology.
- **Computer network architects** design and implement data communication networks, including local area networks, wide area networks, and intranets.
- **Computer programmers** write, modify, and test code and scripts that allow computer software and applications to function properly.
- **Computer support specialists** maintain computer networks and provide technical help to computer users.
- **Computer systems analysts** study an organization's current computer systems and design ways to improve efficiency.
- **Database administrators and architects** create or organize systems to store and secure data.
- **Information security analysts** plan and carry out security measures to protect an organization's computer networks and systems.
- **Network and computer systems administrators** install, configure, and maintain organizations' computer networks and systems.
- **Software developers** design computer applications or programs. **Software quality assurance analysts and testers** identify problems with applications or programs and report defects.
- **Web developers** create and maintain websites. **Digital designers** develop, create, and test website or interface layout, functions, and navigation for usability.

GLOSSARY

AI+ (Artificial Intelligence +): More than AI alone, AI+ refers to the integration of AI with human skills, complementary technologies, and societal systems to drive innovation, opportunity, and resilience.

AI agents: Tools that use advanced AI to understand and undertake multistep processes with limited input from users. They are able to solve problems, make decisions, and even navigate external environments to complete complex tasks in areas such as inquiry response, code generation, software design, and automation.[95]

AI literacy: The knowledge and skills to understand how AI tools operate, determine their judicious use, evaluate their outputs critically, and consider the most effective and ethical use of those outputs in all contexts.[96]

Artificial general intelligence (often referred to as AGI): A hypothetical stage of AI development in which machines could approach or exceed human-level intelligence across tasks, especially as compared to AI optimized for specific functions like conversation or code generation. AGI remains a concept under active debate and research, with no current system possessing the full range of human reasoning, judgment, or adaptability.[97]

Competitiveness: In this report, *competitiveness* may refer to economic competitiveness, emphasizing technology's role in economic growth and global trade, or strategic competitiveness, focusing on developing strategically significant technologies even at the expense of economic concerns. These objectives are closely linked, and this report recognizes the importance of both.

Computational thinking: A set of skills and practices used to solve complex problems, learn across disciplines, and engage effectively in a world driven by computing technology.[98]

Computer programming: Often considered synonymous with **software engineering**, computer programming involves developing instructions for a computer to execute, including debugging code and using it to solve problems.[99]

Computing: The skills and practices used in CS and computational thinking.[100]

Digital fluency: The ability to search for, analyze, and apply information and technology judiciously, especially to adapt and use various tools effectively across a lifetime.[101]

Durable skills: Skills that are—and are expected to remain—useful in any context, such as critical thinking, decision-making, creativity, communication, collaboration, resilience, adaptability, empathy, and innovation.[102]

Generative AI (often referred to as GenAI): A class of AI algorithms that generate new material based on the content used to train them, especially as compared to traditional AI systems that can only make predictions based on observed patterns.[103]

Impact capital: In this report, *impact capital* refers to both philanthropic funding and investment capital intentionally deployed to generate social and economic benefits, alongside—or in some cases instead of—financial returns. We use it both inclusively and alongside philanthropy in our descriptions.

Reskilling: The process of learning new skills that do not relate to an existing skill set, especially for the purpose of training for a new job or career path.[104]

Upskilling: The process of learning new skills that build on an existing skill set, especially for the purpose of advancing in a career or meeting higher standards of work. [105]

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Previously, Aragon worked with first-generation college students, helping them enhance their higher education experience and access research opportunities. She has also worked with nonprofits and business associations to assess their workforce needs and identify talent. Aragon received a Master of Arts in education transformation, focused on policy and advocacy, from Georgetown University, and a bachelor's degree in law and society, with a minor in psychology, from American University. She was named a Gates Millennium Scholar, and currently serves as a Big Sister in her local Big Brothers Big Sisters of America program.

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