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Developing Careers of the Future:

A Study of Student
Access to, and Interest
in, Computer Science

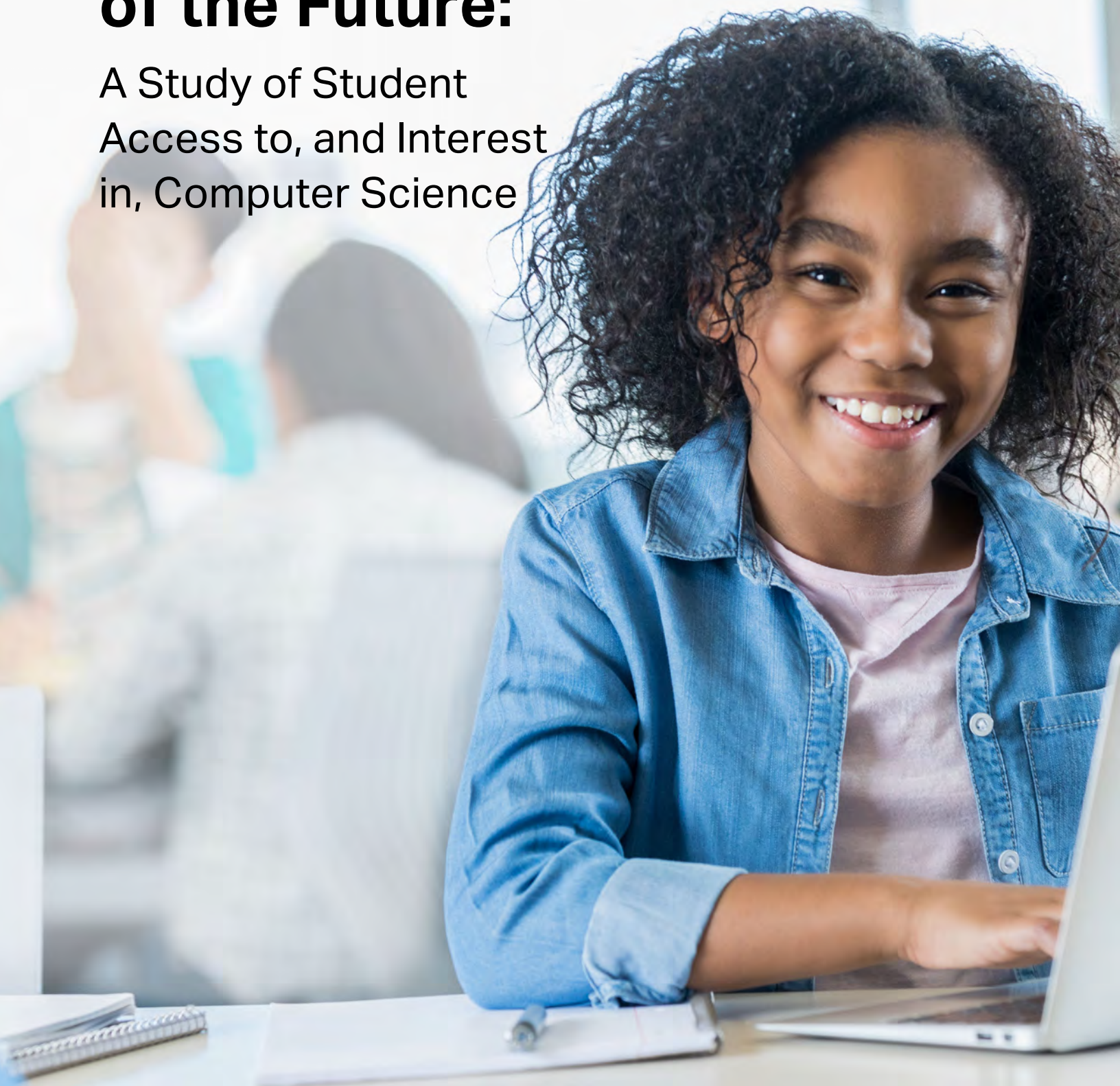


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INTRODUCTION

Computer science skills are among the most sought-after in the U.S. job market, as reflected in the shortage of qualified applicants to fill available computer science-related jobs in the U.S. The U.S. Bureau of Labor Statistics projects that employment in computer and IT-related jobs will grow 11% between 2019 and 2029, much faster than overall job growth in the country.¹ However, the undersupply of computer science skills is also a reflection of the “opportunity gap” in the U.S. economy.² Many students — especially those from underserved and historically underrepresented communities, such as Black, Hispanic and low-income students — lack computer science learning opportunities in school and exposure to the field more broadly in their lives.

Without the experiences and relationships that spark and sustain students’ interest in computer science and help them envision computer science-related careers for themselves, many who would otherwise pursue rich opportunities in the field may fail to even consider them. Among others who do have some computer science exposure, interest in the topic may wane if their experiences with it are infrequent or uninspiring as they begin to think about their post-graduation plans.

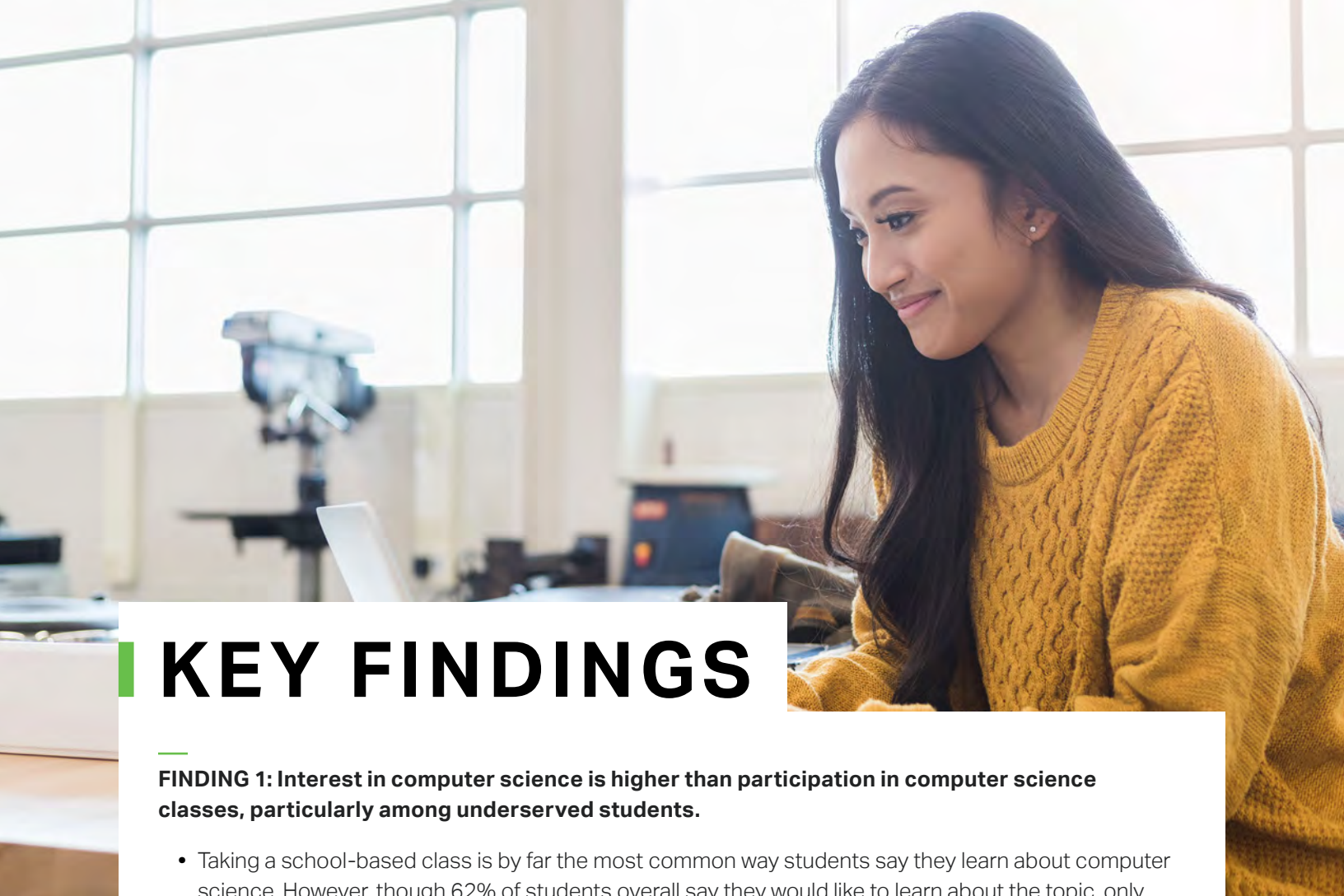
The Amazon Future Engineer/Gallup Student Survey addresses these concerns by asking 4,116 U.S. students in fifth through 12th grade about their interest in and engagement with computer science, both inside and outside of school. The study addresses students’ perceived access to computer science learning opportunities and how positively they view those opportunities, as well as the extent to which they engage with influential people in their lives — including their role models, peers and parents — regarding the topic.

The data also show how students’ experiences with computer science relate to important outcomes, including students’ overall interest in computer science, as well as their plans to pursue the topic in college and as a career. These findings offer new insights to educators and employers who seek to help students from all backgrounds attain the resources and skills to build their best futures.

Beyond this first report, Amazon Future Engineer, Amazon’s global computer science education program, will develop future studies that further disaggregate data at the intersection of income, race and gender. A thorough understanding of racial, gender and socioeconomic differences in students’ access to computer science education will be especially important in the coming years as the long-term effects of COVID-19 on underserved communities become clear.

1 <https://www.bls.gov/ooh/computer-and-information-technology/home.htm>

2 <https://www.brookings.edu/blog/the-avenue/2020/09/09/the-labor-market-doesnt-have-a-skills-gap-it-has-an-opportunity-gap/>



KEY FINDINGS

FINDING 1: Interest in computer science is higher than participation in computer science classes, particularly among underserved students.

- Taking a school-based class is by far the most common way students say they learn about computer science. However, though 62% of students overall say they would like to learn about the topic, only 49% have taken a computer science class.
- These gaps between student interest and participation in computer science classes are particularly large for students in lower-income households (among those in households earning less than \$48,000 a year, 59% are interested but 37% have taken a class), as well as Black students (60% vs. 42%) and Hispanic students (61% vs. 44%).
- Overall, 70% of students say computer science classes are available at their school. However, this figure is significantly lower among underserved groups, particularly rural students in low-income households (46%).
- In large cities, where computer science classes are more common, Black (67%) and Hispanic (81%) students are less likely than White students (88%) to say their school offers them.

FINDING 2: Access to computer science learning opportunities strongly predicts students' interest in the topic.

- Sixty-eight percent of students who say computer science classes are offered at their school are interested in learning about the topic, vs. 49% of those in schools that do not offer classes. Access to classes predicts student interest even after controlling for students' demographic characteristics and other factors.
- Students with access to school-based computer science classes are also more than twice as likely as those without to say they plan to study the topic in college (42% vs. 18%, respectively) and that they aspire to have a job in the field (43% vs. 15%).

FINDING 3: Access to high-quality computer science classes also helps sustain students' interest in computer science as they get older.

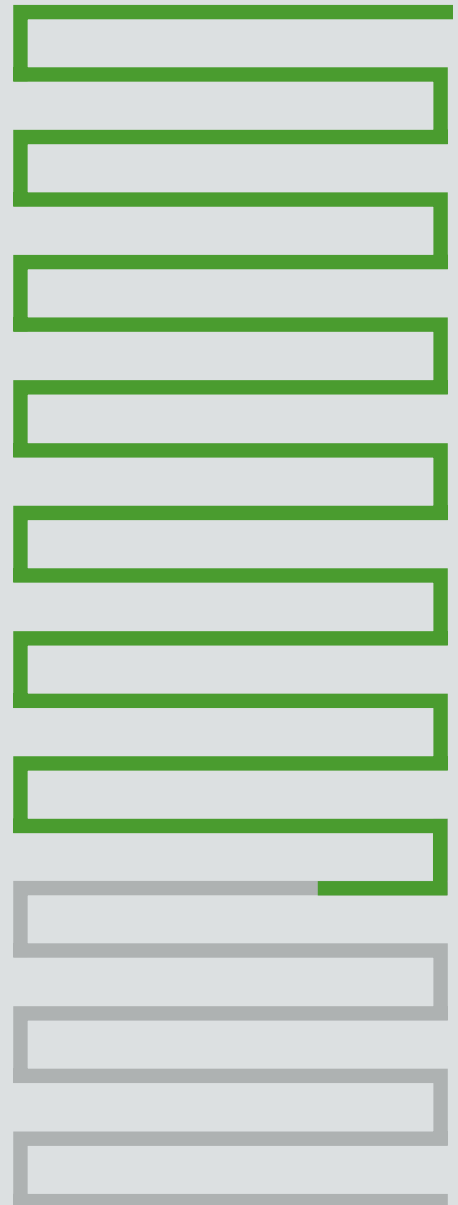
- Student interest is more prevalent at all grade levels in schools that offer computer science classes, and it does not drop as sharply between fifth and 12th grade as it does in schools where classes are not available. Among students without access to computer science classes, interest falls from 63% among fifth graders to 23% among 12th graders. Where classes are available, interest falls from 85% in fifth grade to 59% in 12th grade.
- Among students in lower-income households, interest in computer science falls sharply from 70% in fifth through sixth grade to less than half in seventh through ninth grade if their school does not have classes in the subject. Where classes are available, interest is largely sustained.
- Having fun and engaging classes also helps fuel interest in computer science; for example, 90% of students who strongly agree that their computer science class was fun want to learn more about it, vs. 26% of those who disagree.

FINDING 4: Role models are strongly linked to students' computer science career plans.

- Overall, 35% of students say they plan to someday have a job in a computer science-related field. However, this number rises to 73% among students who strongly agree that they have computer science role models, vs. 7% of those who strongly disagree.
- This relationship holds among students across demographic groups — including girls, Black and Hispanic students and low-income students. For example, students in households earning less than \$48,000 a year are more than six times as likely to aspire to a career in computer science if they strongly agree they have a role model in the field (66%) than if they strongly disagree (10%).
- Just over half of students (53%) agree that they have a role model in computer science. Though this figure is somewhat lower among girls (49%) and Black students (45%), the biggest difference is between students in large cities (72%) and those in rural areas (36%). This urban/rural gap is likely related to the corresponding difference in access to computer science classes, since teachers may often be the role models. Overall, 61% of students who have taken a computer science class at school say they have role models in the topic, vs. 45% of those who have not taken a class.

73%

of students who strongly agree they have role models in computer science say they have plans or hope to someday have a job in a computer science-related field.



FINDING 5: Sharing computer science interest with peers fuels students' intent to study the subject in college

- About four in 10 students (43%) say they talk about or participate in computer science activities with friends outside of school. Two-thirds of those who have such peer interactions (67%) say they plan to study computer science in college, vs. 13% of those who do not.
- Students are far more likely to engage with peers about computer science if they participate in “extracurricular” computer science activities than if they do not — including clubs (79% vs. 37%), community programs (77% vs. 40%) or camps (74% vs. 41%).

FINDING 6: There remains a sizable gender gap in computer science interest — except among Black students.

- Overall, 53% of girls say they are interested in learning about computer science, vs. 72% of boys. Girls are significantly less likely than boys to say they plan to study computer science in college (27% vs. 46%) or that would someday like to have a job in a computer science-related field (26% vs. 43%).
- Among Black students, however, girls are about as likely as boys to say they are interested in learning about computer science — 61% vs. 59%. While Black boys are less likely than White or Hispanic boys to be interested in the topic (59% vs. 75% and 72%, respectively), Black girls are more likely than White or Hispanic girls to be interested (61% vs. 51% and 52%).
- Black girls are more likely than White girls to say they talk about or participate in computer science activities with friends outside of school — 44% vs. 30%, respectively.

Overall, **53% of girls** and **72% of boys** are interested in learning more about computer science. That gender gap virtually disappears among Black students: **61% of girls** are interested vs. **59% of boys**.



BACKGROUND

People with a computer science bachelor's degree can expect to earn \$1.86 million over their career,³ compared with \$1.28 million for other bachelor's degree recipients.⁴ Nonetheless, there were approximately 360,000 job vacancies for computer occupations during a typical month before the pandemic and just over 216,000 at the end of 2020. In total, and adjusting for estimated repostings over the course of the year, this implies a total of just under 2 million unique job openings for all of 2020.⁵ In July 2021, the unemployment rate for workers in computer occupations was 1.5%, the lowest among all occupations and far below the national unemployment rate of 5.7%. Computer occupations also had the highest ratio of unfilled job vacancies to the current workers and the highest ratio of vacancies to unemployed workers.⁶

The booming demand for computer science skills reflects the reality that they are needed not just — or even primarily — in tech companies anymore, but in *all* companies.⁷ Further, computer science skills are increasingly relevant to a much broader array of jobs than in the past. The Organization for Economic Cooperation and Development (OECD) finds that digital literacy skills are widely needed across occupations and consistently associated with better pay.⁸ Research from the Brookings Institution further highlights the growing reliance on STEM-based skills generally, and information and computer technology skills specifically, to a growing segment of innovation-rich industries.⁹

3 https://www.hamiltonproject.org/charts/career_earnings_by_college_major/, 50th percentile of lifetime earnings for computer science bachelor's degree holders.

4 Kristen Broady and Brad Hershbein, "Major decisions: What graduates earn over their lifetimes" (Brookings Institution, 2020), <https://www.brookings.edu/blog/up-front/2020/10/08/major-decisions-what-graduates-earn-over-their-lifetimes/>

5 Burning Glass, analysis of open data, <https://www.burning-glass.com/research/open-data-job-postings/>. Historical reposting rates from Jonathan Rothwell, "Still Searching: Job Vacancies and STEM Skills" (Brookings Institution, 2014), available at <https://www.brookings.edu/interactives/still-searching-job-vacancies-and-stem-skills/>

6 U.S. Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey. August 6, 2021. <https://www.bls.gov/web/empsit/cpseea30.htm>

7 <https://www.cnbc.com/2017/08/10/every-company-is-a-tech-company-including-blue-apron.html>

8 OECD "Skills Matter: Additional Results from the Survey of Adult Skills," https://www.oecd-ilibrary.org/education/skills-matter_1f029d8f-en

9 Mark Muro et al "Digitalization and the American workforce" (Washington: Brookings Institution, 2017), <https://www.brookings.edu/research/digitalization-and-the-american-workforce/>; Mark Muro et al "America's Advanced Industries: What They Are, Where They Are, and Why They Matter" (Washington: Brookings Institution, 2015), <https://www.brookings.edu/research/americas-advanced-industries-what-they-are-where-they-are-and-why-they-matter/>

However, data from the Department of Education shows that the number of computer science awards granted by U.S. higher-education institutions was 215,000 in 2019 at all levels (from certificates to doctorates). At current 10-year growth rates, the number of computer science awards would increase to approximately 422,000 per year by 2029. Yet, many of these awards would be granted to foreign students who would not necessarily work in the United States and are comprising a rapidly growing share of award recipients (from 10% in 2009 to 18% in 2019). A forecast using only U.S. residents suggests that 2029 would see only 321,000 awards in computer science.¹⁰

Increasing computer science exposure among underrepresented groups can create pathways to success.

One significant constraint on supply and innovation within the field is the limited representation of women and Black and Hispanic workers in computer science careers. For example, BLS data indicate that just 21% of computer programmers were women¹¹ in 2020, while 6% were Black¹² and 7% were Hispanic¹³ (by comparison, recent Census figures indicate about 13% of all Americans are Black and 19% are Hispanic).¹⁴ Children from low-income households, including many Black or Hispanic children, are less likely to have the support systems beginning at an early age that increase students' likelihood to pursue a career in computing.¹⁵

Research shows early exposure to computer science and other STEM topics is important because it stimulates students' interest, builds self-confidence, and fosters a sense of belonging.¹⁶ Confidence and sense of belonging are especially important for female students, who are more likely to experience stereotype threat — in this case, the notion that girls don't have the same aptitude for computer science that boys do.¹⁷

Among AP computer science exam takers in 2019, only 29% were girls, 6% were Black, and 17% were Hispanic — well below the proportions of each group among the total student population.¹⁸ Inequality in access goes beyond exposure at school.

10 IPEDS Trend Generator, <https://nces.ed.gov/ipeds/trendgenerator/>

11 <https://beta.bls.gov/dataViewer/view/timeseries/LNU02070004>

12 <https://beta.bls.gov/dataViewer/view/timeseries/LNU02070539>

13 <https://beta.bls.gov/dataViewer/view/timeseries/LNU02071609>

14 U.S. Census QuickFacts, retrieved August 31, 2021. <https://www.census.gov/quickfacts/fact/table/US/PST045219>

15 Margolis, J., Estrella, R., Goode, J. Holme, J.J. and Nao, K. (2008). *Stuck in the shallow end: Education, race, and computing*. Cambridge, MA: MIT.

16 Master, A., Cheryan, S., Moscatelli, A., & Meltzoff, A. N. (2017). Programming experience promotes higher STEM motivation among first-grade girls. *Journal of experimental child psychology*, 160, 92-106; Braswell, K. M., Johnson, J., Brown, B. A., & Payton, J. (2021, March). Pivoting during a pandemic: Designing a virtual summer camp to increase confidence of black and latina girls. In *Proceedings of the 52nd ACM Technical Symposium on Computer Science Education* (pp. 686-691).
Chen Chen, Paulina Haduong, Karen Brennan, Gerhard Sonnert & Philip Sadler (2019) The effects of first programming language on college students computing attitude and achievement: a comparison of graphical and textual languages, *Computer Science Education*, 29:1, 23-48

17 National Center for Women and Information Technology (WIT) (2020), *Learning from Young Women: A Multi-Year NCWIT Research Study*

18 Code.org. Advocacy Coalition, "2020 State of Computer Science Education: Illuminating Disparities."

Extracurricular activities like coding camps remain out of reach for students with limited financial resources or those living in regions without such programs.¹⁹

Given the undersupply of talent and inequities in the field, there is a need to both expand access among K-12 students to formal and informal computer science learning opportunities, particularly among students from underresourced and historically underrepresented communities, and to reframe stereotypes that discourage some types of students from studying computer science.

Recognition of this reality has led to calls for democratizing computer science, and recent presidential administrations have made expanding access to computer science career pathways a priority.^{20, 21} The push for more equitable access to computer science education serves two objectives. First, it will unlock a talent pool that fuels dynamism and growth in key sectors of the U.S. economy. Second, a career in computer science offers a pathway to upward economic mobility, as the median annual wage for computer and IT occupations is about \$91,000, far higher than the \$42,000 median wage for all occupations.²²

19 Kapor Center for Impact (2018), *The Leaky Tech Pipeline: A Comprehensive Framework for Understanding and Addressing the Lack of Diversity across the Tech Ecosystem*

20 The White House. (2016). *Weekly Address: Giving Every Student an Opportunity to Learn Through Computer Science For All*. January 30, 2016. <https://obamawhitehouse.archives.gov/the-press-office/2016/01/30/weekly-address-giving-every-student-opportunity-learn-through-computer>

21 The White House. (2021). *Fact Sheet: How the Biden-Harris Administration Is Advancing Educational Equity*. July 23, 2021. <https://www.whitehouse.gov/briefing-room/statements-releases/2021/07/23/fact-sheet-how-the-biden-harris-administration-is-advancing-educational-equity/>

22 <https://www.bls.gov/ooh/computer-and-information-technology/home.htm>

SURVEY METHODS

Results for the Amazon Future Engineer/Gallup Student Survey are based on a web survey conducted June 2-20, 2021, with a sample of 4,116 U.S. public and private school students in grades 5-12. Gallup corrected for lower response rates among some groups by weighting the obtained samples to match national demographic targets for gender, grade, race/ethnicity, and school type. Weighting targets were based on the U.S. Census Bureau's American Community Survey for 2019. See page 33 for full methodological details.



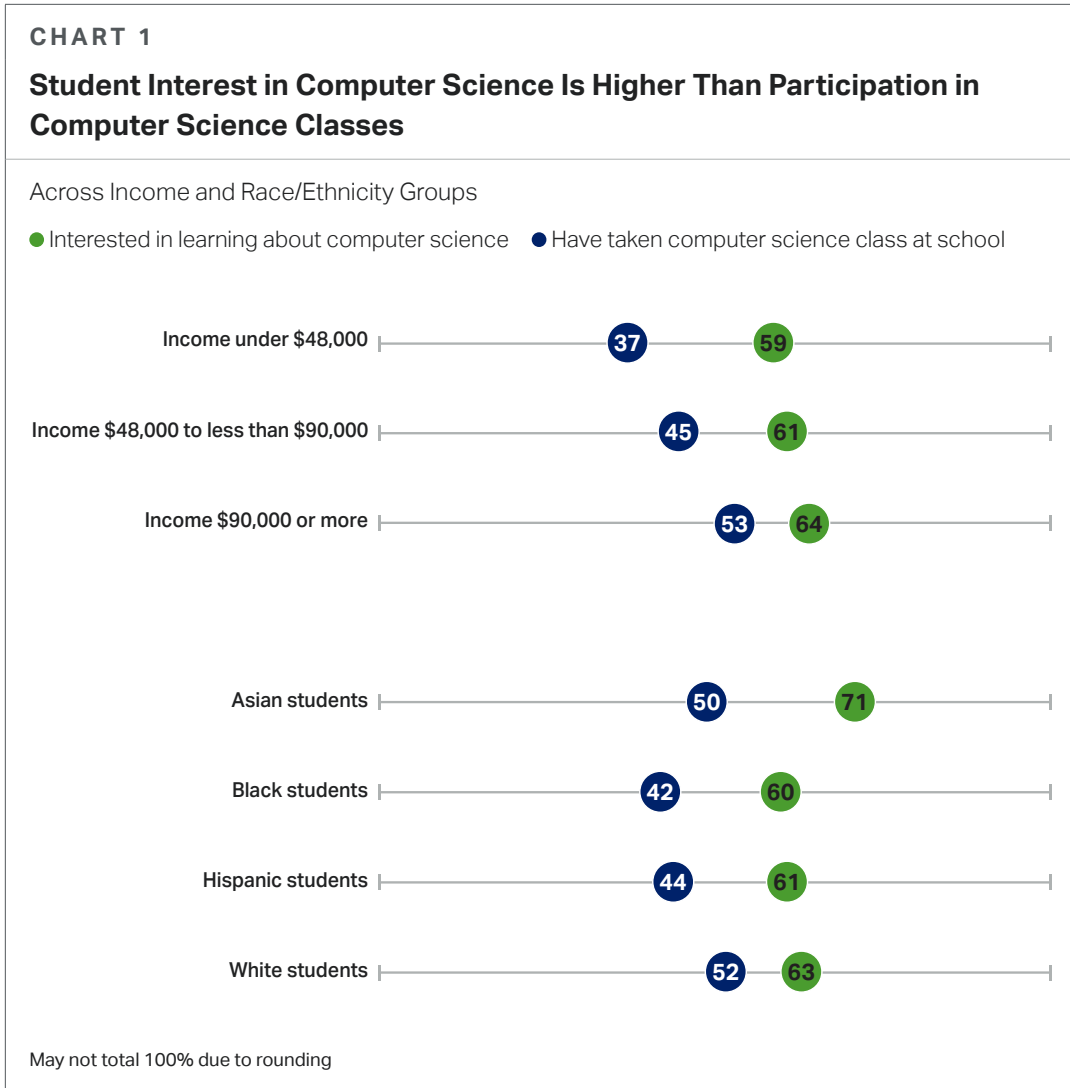
DETAILED FINDINGS

FINDING 1: Interest in computer science is higher than participation in computer science classes, particularly among students from underserved communities.

Overall, 62% of students say they are interested in learning about computer science (or learning more if they have already had some computer science education) — but just 49% say they have learned computer science in a class at school.

Students' interest in computer science is very consistent across household income levels; in each income group, close to six in 10 say they'd like to learn (or learn more) about the topic. Similarly, students' interest levels don't vary much by their racial or ethnic background, with interest somewhat higher only among Asian students. (There does, however, remain a sizeable gender gap in computer science interest — see page 29.)

However, students' participation in computer science classes at school lags the percentage who are interested in the topic among all groups. These gaps are particularly wide among students in lower-income households and Black and Hispanic students; for example, while 59% of students in households earning under \$48,000 express interest in topic, just 37% have taken a school-based computer science class.



Beyond these broad discrepancies by race and income, the data reveal additional differences that are relevant to those seeking to increase student engagement with computer science. Reflecting previous research on the “digital divide” between urban and rural areas — including a recent study of students, parents and educators by Google and Gallup²³ — students in large cities are more likely to both express interest in and have participated in computer science classes at school than those in more rural areas.

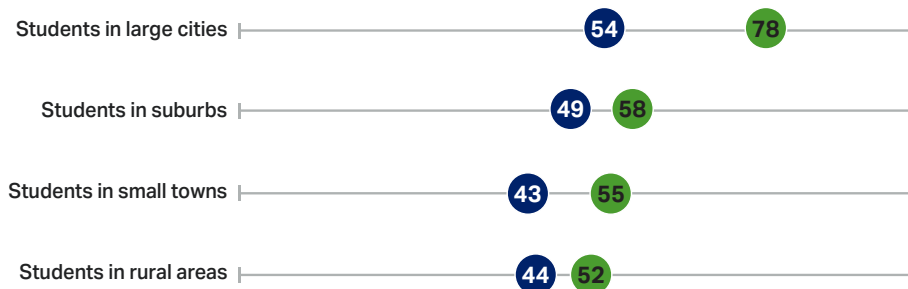
23 Google LLC & Gallup, Inc. (2020). Current Perspectives and Continuing Challenges in Computer Science Education in U.S. K-12 Schools. Accessed from <https://services.google.com/fh/files/misc/computer-science-education-in-us-k12schools-2020-report.pdf>

CHART 2

Students' Interest in Computer Science and Participation in Computer Science Classes

By Urbanicity

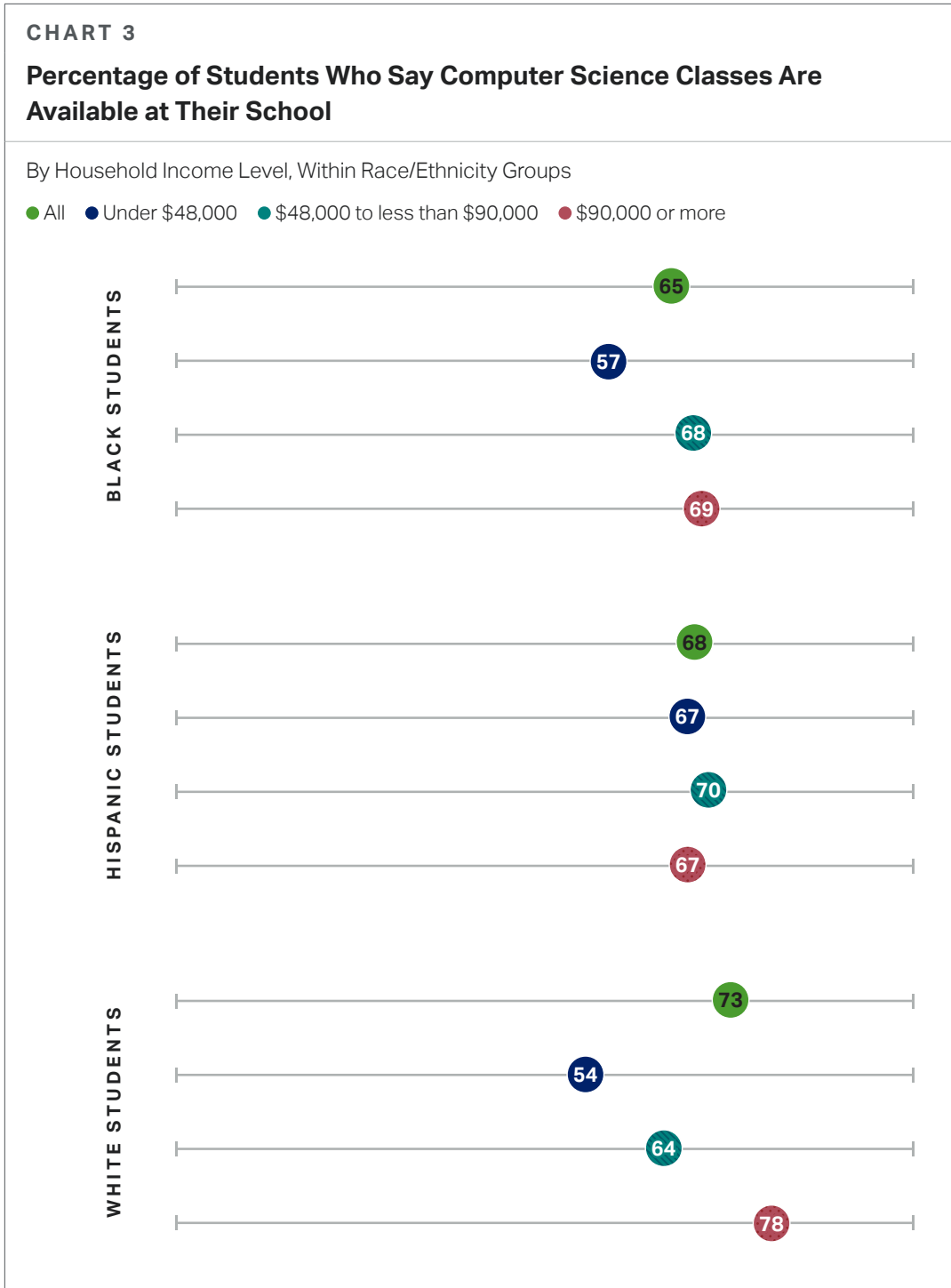
● Interested in learning about computer science ● Have taken computer science class at school



The Amazon Future Engineer/Gallup Student Survey's large sample makes it possible to see how this urban/rural distinction intersects with students' race/ethnicity and household income levels for a more nuanced view of computer science interests and access. Two patterns stand out:

- 1) White students' access to computer science education is strongly related to whether they live in an urban or rural area — and therefore also to their household income level. Black and Hispanic students in low-income households are more likely than low-income White students to live in large cities, which helps limit the variation by income in their access to computer science education. Among White students, however, those in lower-income households are also more likely to live in rural areas; White students in rural areas are more than four times as likely as those in large cities to live in households that earn \$48,000 or less (18% vs. 4%, respectively).

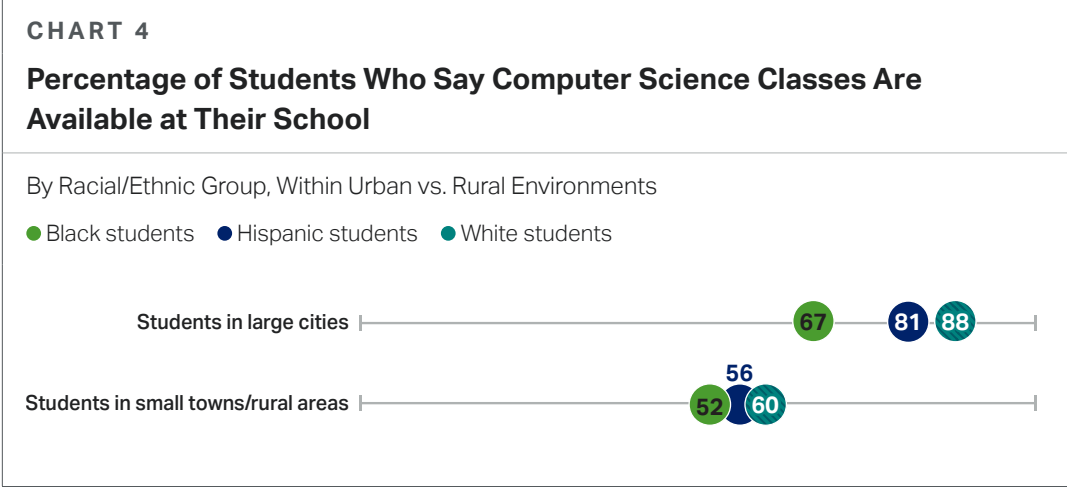
The related effects of income and urbanicity combine to make low-income White students much less likely than higher-income White students to have access to computer science education. Overall, 70% of students say computer science classes are available at their school — but this number drops to 54% among lower-income White students, while rising to 78% among those in households that earn \$90,000 or more.



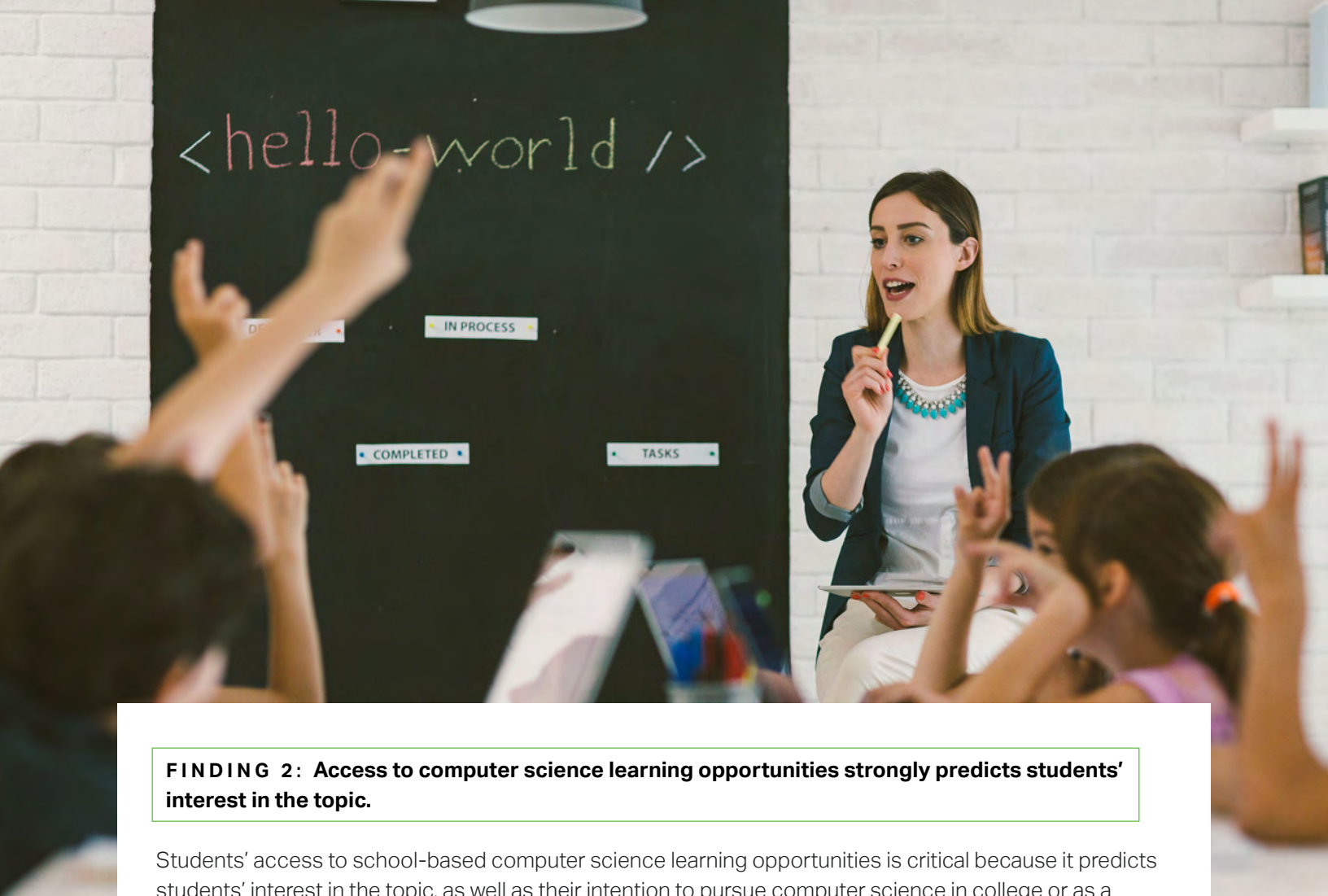
2) In large cities, there are sizable differences by race/ethnicity in computer science access. Overall, White students are somewhat more likely than Black students to say computer science classes are available at their school — 73% vs. 65% — with Hispanic students in between at 68%. However, when the focus is narrowed to large cities, where residential segregation by race and ethnicity is more common, the differences widen

considerably. Most notably, 67% of Black students in cities say computer science classes are offered at their school, vs. 88% of White students.

Among students in small towns and rural areas, the percentages of Black, Hispanic and White students who say their school offers computer science classes are all statistically closer — and all significantly below the corresponding percentages among students in large cities.



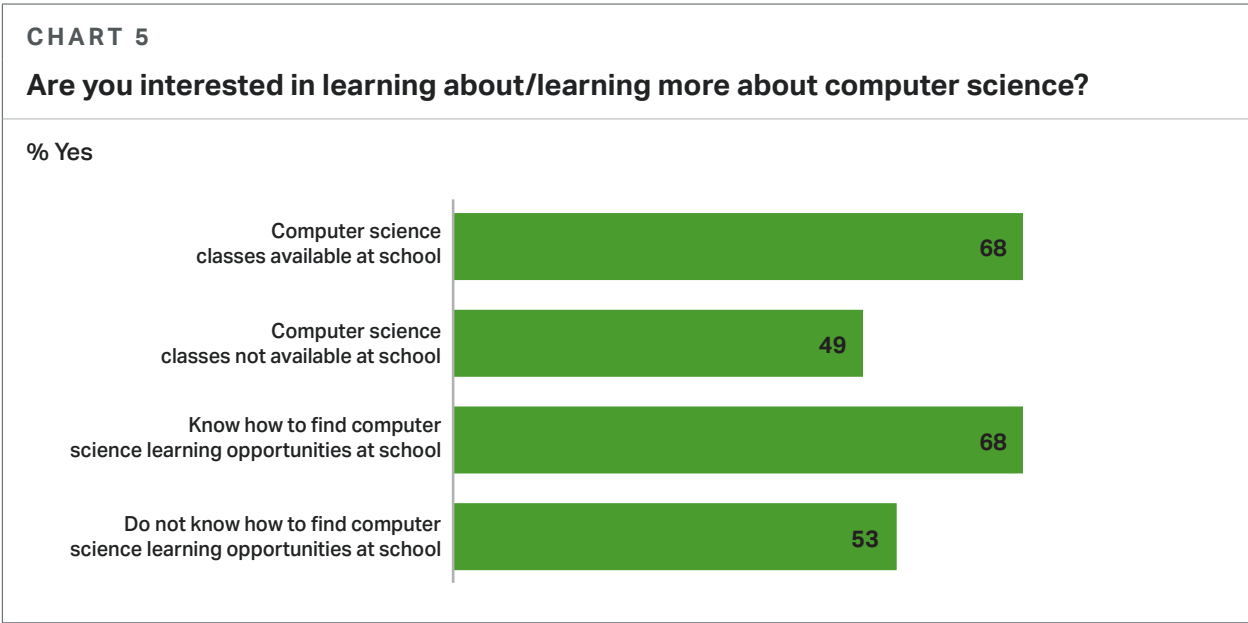
In large cities, **67% of Black students** say computer science classes are available at their school, vs. **88% of White students**.



FINDING 2: Access to computer science learning opportunities strongly predicts students' interest in the topic.

Students' access to school-based computer science learning opportunities is critical because it predicts students' interest in the topic, as well as their intention to pursue computer science in college or as a career. These relationships remain even after controlling for student demographics and other factors that might influence interest, suggesting the availability of learning opportunities alone makes a difference.

Students who say computer science classes are offered at their school, or that they know where to find computer science learning opportunities in their school, are significantly more likely than students who are not aware of such opportunities to say they are interested in learning more about computer science.



Students who have access to school-based computer science classes are also more than twice as likely as those who do not to say they plan to study the topic in college (42% vs. 18%) and almost three times as likely to aspire to have a job in the field (43% vs. 15%). However, much of the difference is accounted for by higher “don’t know” responses among students whose schools do not offer computer science classes, suggesting many simply do not have enough information about opportunities in the field.

CHART 6

Students Who Say Computer Science Classes Are Available at Their School Are More Likely to Have Plans to Study the Topic in College and Get a Job in the Field, and Less Likely to Say They “Don’t Know” if They Will Pursue Computer Science Education or Professions.

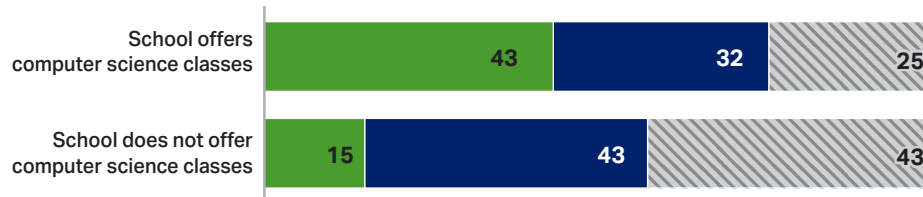
Do you have plans or hope to someday go to college for computer science or a computer science related major?

● Yes ● No ● Don't Know



Do you have plans or hope to someday have a job in a computer science related field?

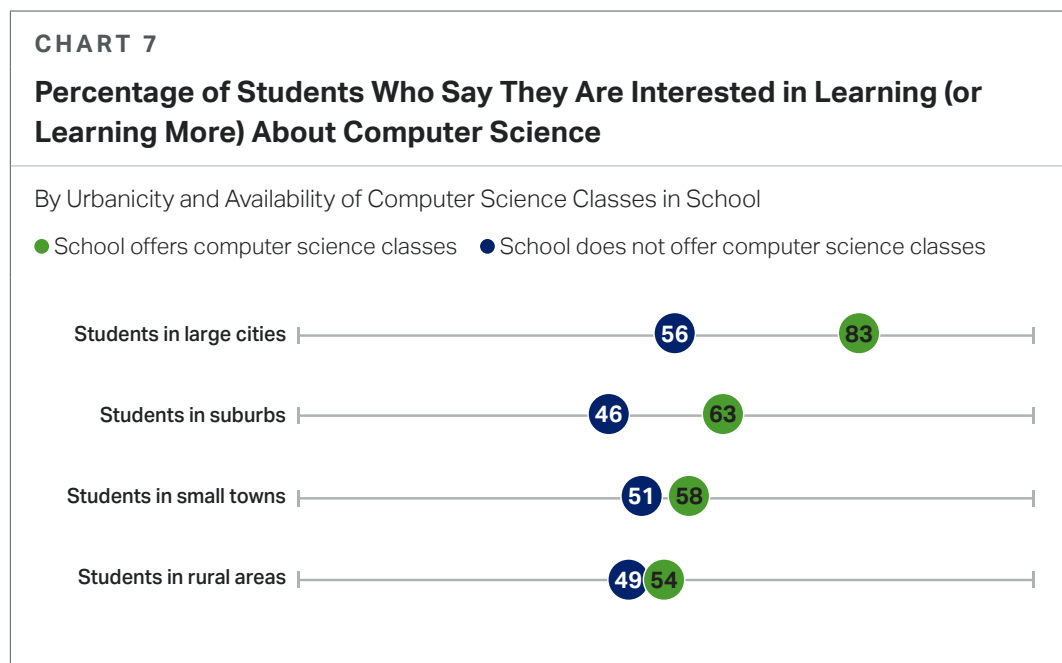
● Yes ● No ● Don't Know



Given these higher levels of uncertainty among students without access to computer science classes, one implication for educators and policymakers is that it may be wrong to base decisions about providing computer science learning opportunities on perceived student interest. Those opportunities may be needed to spark students’ interest and lead more of them to see computer science skills as relevant to their future plans.

The relationship between access to and interest in computer science is strongest in large cities, where overall interest is higher and students may be more likely to envision a career in the field. However, the availability of computer science classes in their school is also associated with significantly higher student interest levels in suburbs and small towns.

Notably, the presence of computer science classes is not as predictive of student interest in rural areas. Rural students may simply be less likely to view the topic as relevant to their future career prospects, regardless of whether or not they have opportunities to learn about it. Only about one in six students in rural areas (17%) plan to someday have a job in a computer science-related field, vs. a majority (58%) of those who live in large cities.



In turn, students' level of interest in computer science is related to the likelihood that they will be engaged with the field over the long term. Those who say they are interested in learning more about the topic are much more likely to say they plan to go to college for computer science, and that they hope to someday have a job in computer science or another STEM field.



FINDING 3: Access to high-quality computer science classes also helps sustain students' interest in computer science as they get older.

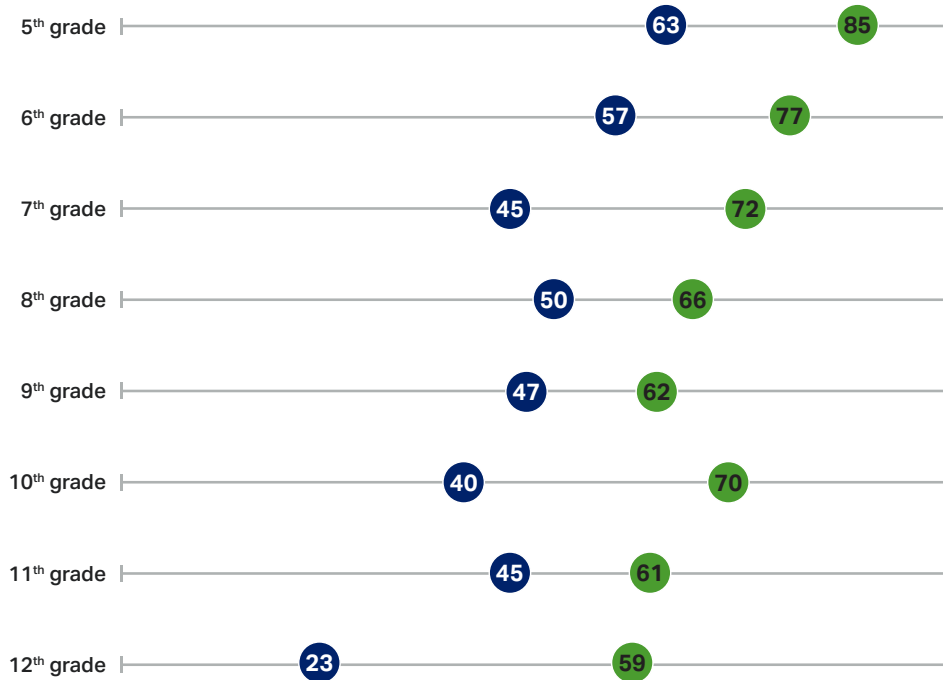
Students' interest in computer science generally drops in higher grade levels, as students begin to consider likely career paths and their areas of focus diversify. However, interest is higher at all grade levels in schools that offer computer science classes, and it does not drop as sharply between fifth and 12th grade as it does in schools where classes are not available.

CHART 8

Percentage of Students Who Say They Are Interested in Learning (or Learning More) About Computer Science

By Grade Level and Availability of Computer Science Classes in School

● School offers computer science classes ● School does not offer computer science classes



Access to computer science classes seems to encourage persistence with the topic among students in both lower-income and higher-income households. Among those in households earning under \$60,000, interest drops off sharply after sixth grade in the absence of computer science classes — but it is largely sustained where students say classes are available.

In the absence of computer science classes, student interest in the topic drops most sharply between 11th and 12th grade, possibly reflecting students' increased certainty about post-graduation plans in their senior year. Among students in schools that don't offer computer science classes, 12th-graders are considerably more likely than 11th-graders to say they do *not* plan to someday have a job in a computer science-related field (66% vs. 48%) and less likely to say they don't know (28% vs. 44%).

Among students in households earning \$60,000 or more, interest in computer science is less common, even in the lower grades, if their school doesn't offer classes in the subject. In such schools, interest also drops sharply from half (50%) of higher-income students in grades seven through nine, to about one-third (34%) in grades 10 through 12.

CHART 9

Percentage of Students at Each Grade Level Who Say They Are Interested in Learning About Computer Science

By Household Income and Availability of Computer Science Classes in School

Household Income Under \$60,000

● Grades 5-6 ● Grades 7-9 ● Grades 10-12



Household Income of \$60,000 or More

● Grades 5-6 ● Grades 7-9 ● Grades 10-12



A variety of other factors also appears to help counteract the decline in computer science interest by grade level — including the presence of computer science role models in their lives, engagement with computer science in their peer networks, their interest in computer science-adjacent topics, such as how video games and the internet work, and their level of interest in school generally.

Having fun and engaging classes helps fuel interest in computer science.

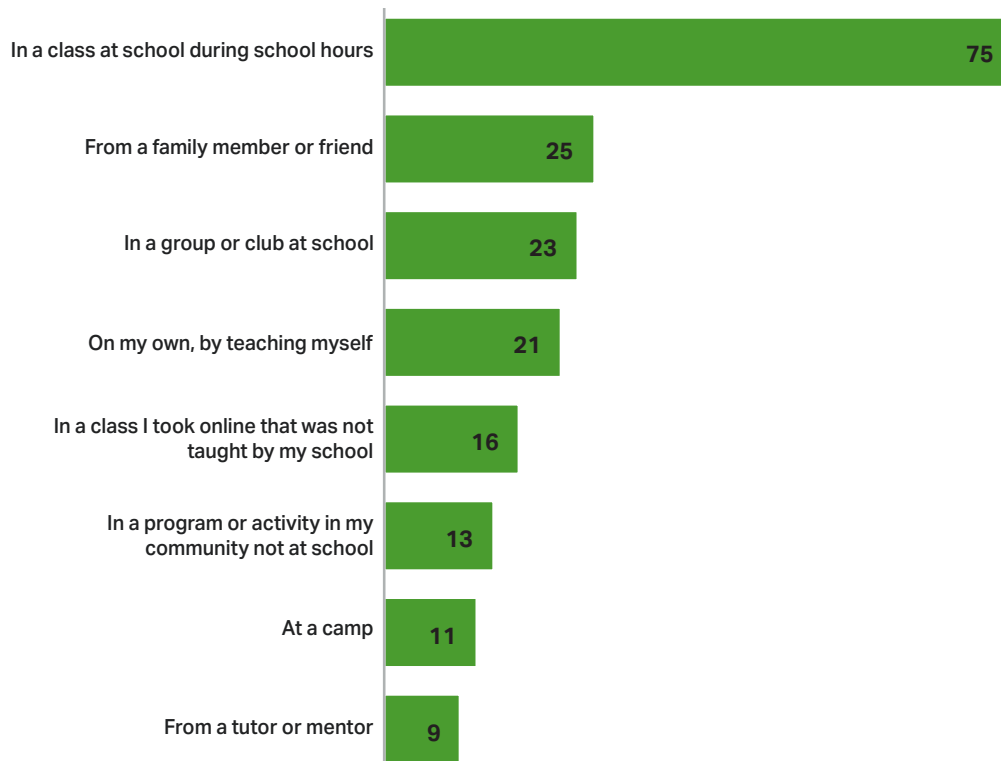
Participation in a school-based computer science class is by far the most common way students engage with computer science. Among those who say they have learned computer science by any means, three-fourths (75%) said they had done so in a class at school. No other means of learning came close, with learning about computer science from a family member or friend as a distant second at 25%. These results are generally consistent by students' demographic characteristics among those who say they have learned any computer science.

CHART 10

Where have you learned computer science? You may select one or more.

Asked of Students Who Said They Had Ever Learned Any Computer Science

% Selected



These results demonstrate the importance of school-based computer science classes, without which many more students would have no exposure to the subject. However, the Amazon Future Engineer/Gallup Student Survey results indicate that it isn't just the availability of computer science classes that helps promote student interest — the quality of those classes makes a difference as well.

Overall, 47% of students who had taken a computer science class strongly agree that it was fun, while another 41% somewhat agree and just 12% disagree. Similarly, 40% strongly agree that they learned a lot about computer science, while 47% somewhat agree and 13% disagree.

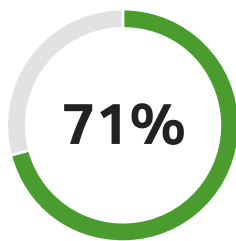
Each rating difference corresponds to a large gap in students' likelihood to be interested in learning more about computer science — even between those who strongly agree and somewhat agree with each statement. Among students who had taken a computer science class at school, nine in 10 of those who strongly agree it was fun or that they learned a lot said they were interested in learning more about the subject. By contrast, just under two-thirds of those who somewhat agree, and well under a third of those who disagree with either statement, are interested in learning more.

CHART 11

Are you interested in learning more about computer science?

Among Students Who Had Taken a Computer Science Class, by Their Level of Agreement That the Class Was Fun

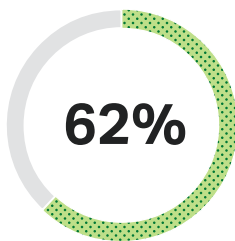
% Yes, Interested



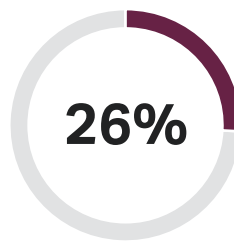
All students who had taken a CS class



Students who strongly agree their CS class was fun



Students who somewhat agree their CS class was fun



Students who disagree their CS class was fun

It's important to note that the causal relationship between student interest and class ratings likely runs both ways. Though learning experiences likely influence students' interest to some extent, those who are more interested to begin with are probably also more predisposed to enjoy the class and learn a lot from it.

Nonetheless, the magnitude of these relationships and their consistency across demographic groups — together with the overall importance of students' access to computer science classes — support the notion that such classes represent critical opportunities to cultivate students' engagement with the topic. Two-thirds of college-bound students who strongly agree that their computer science class was fun (68%) say they plan to study the subject in college, vs. 28% of those who somewhat agree and 10% of those who disagree.

However, prior research suggests many teachers don't feel supported in their efforts to engage students with computer science. For example, a 2020 study by Google and Gallup²⁴ found that, while 58% of school district superintendents agreed that computer science education was a top priority for their district, just 28% of principals and 18% of teachers agreed.

Among students who had taken computer science classes, **68%** of those who **strongly agree** the class was fun plan to pursue the topic in college, vs. **10%** of those who **disagree**.

24 Google LLC & Gallup, Inc. (2020). Current Perspectives and Continuing Challenges in Computer Science Education in U.S. K-12 Schools. Accessed from <https://services.google.com/fh/files/misc/computer-science-education-in-us-k12schools-2020-report.pdf>



FINDING 4: Role models have a powerful influence, especially on computer science career plans.

Beyond school-based computer science classes, the Amazon Future Engineer/Gallup Student Survey also highlights the importance of individuals in students' lives who foster their engagement with computer science — including role models, peers and parents.

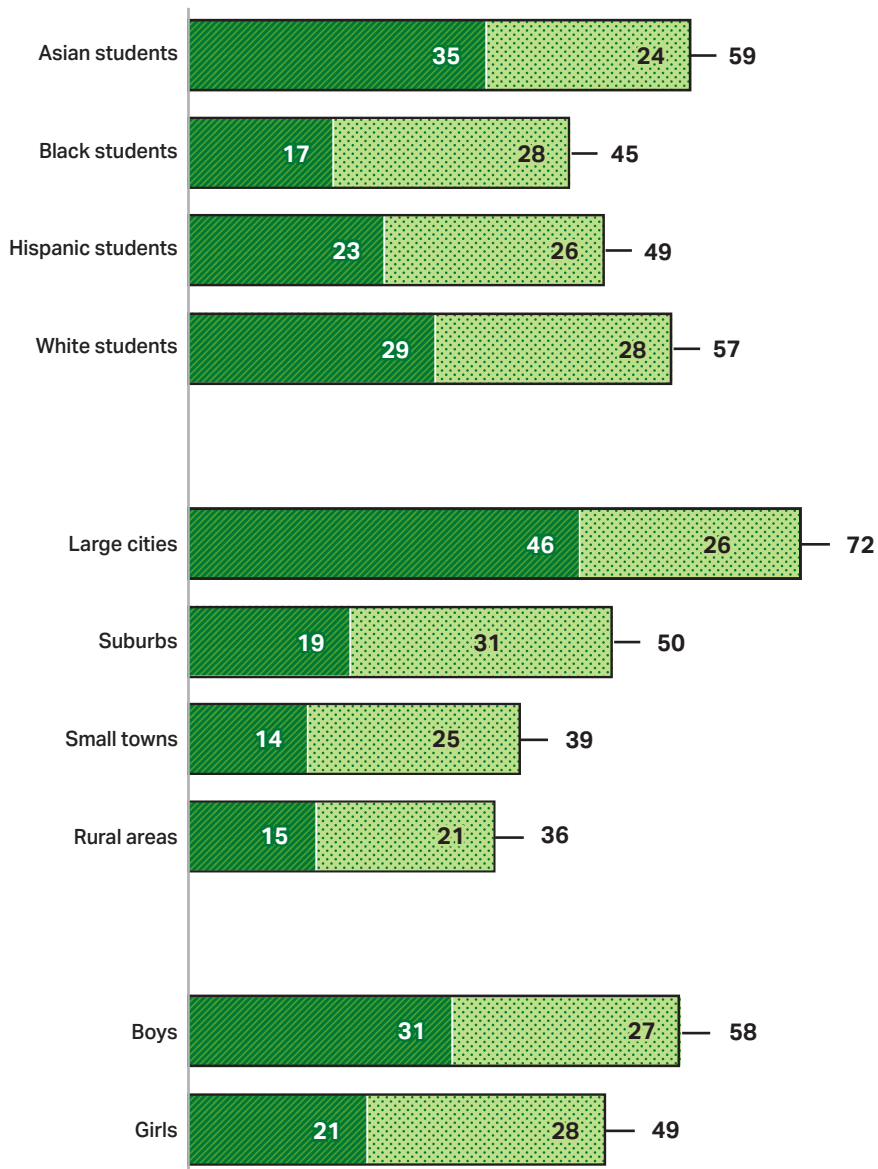
Advanced analyses identify the presence of computer science role models as a major predictor of students' interest in the topic, regardless of their demographic characteristics. Overall, about half of students strongly agree (26%) or somewhat agree (27%) that they have role models in computer science. White and Asian students are somewhat more likely than Black and Hispanic students to agree, and boys are somewhat more likely than girls to do so.

However, like access to computer science classes at school, the biggest predictor of whether students have computer science role models is whether they live in an urban vs. rural environment. Almost three-quarters of students who live in large cities (73%) agree that they have role models in computer science, vs. just over a third (36%) of those who live in rural areas.

CHART 12

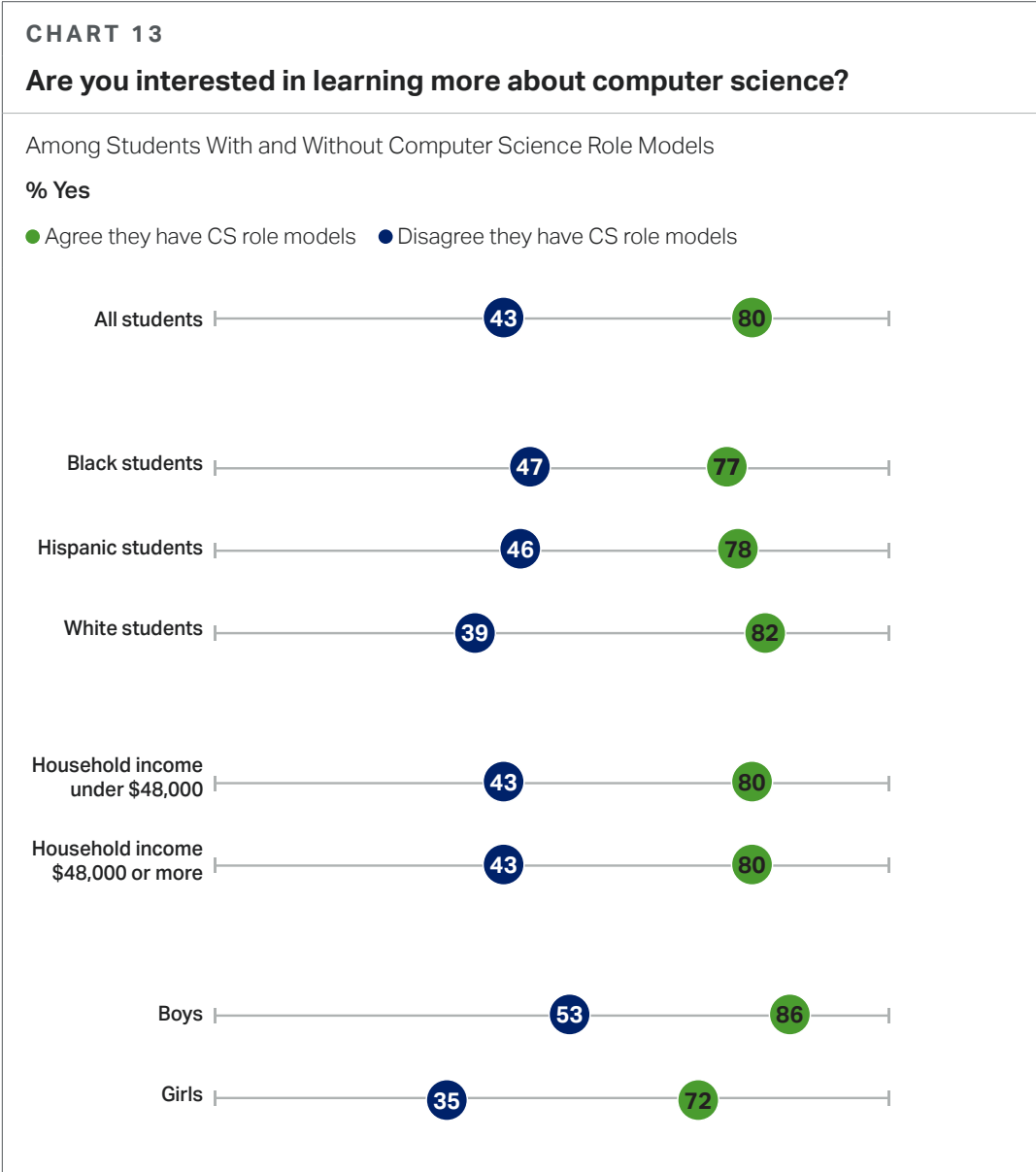
Please rate your level of agreement with the following statement: I have role models in computer science.

● Strongly agree ● Somewhat agree



The gap between urban and rural areas in access to role models is likely related to the corresponding difference in access to computer science classes since teachers may often be the role models. Overall, 61% of students who have taken a computer science class at school say they have role models in the topic, vs. 45% of those who have not taken a class.

Students' interest in computer science, confidence that they can be good at it, and plans to engage with it in college and beyond are all strongly related to the presence of computer science role models in their lives. These relationships are consistent across most demographic groups; among students in each race/ethnicity and household income group, for example, more than three-fourths of those who agree they have computer science role models are interested in learning about the topic, vs. less than half of those who disagree.



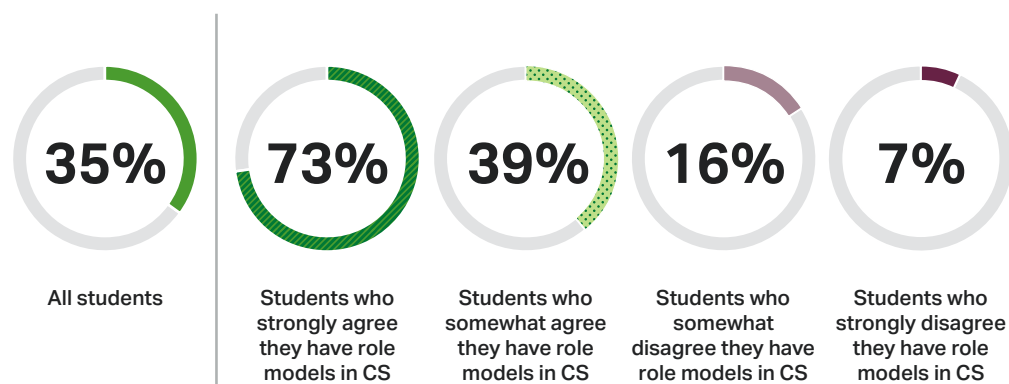
The presence of role models is an especially powerful predictor of students' likelihood to say they plan or hope to someday have a computer science-related job. Among students who strongly agree they have role models in computer science, 73% hope to someday have a job in the field, vs. 7% of those who strongly disagree that they have role models. (Overall, about half of students strongly agree (26%) or somewhat agree (27%) that they have role models in computer science, while 21% somewhat disagree and 26% strongly disagree.)

CHART 14

Do you have plans or hope to someday have a job in a computer science related field?

Asked of Students Who Plan to Attend College

% Yes



Again, this relationship holds among students across demographic groups. For example, students in households earning less than \$48,000 a year are more than six times as likely to aspire to a career in computer science if they strongly agree they have a role model in the field (66%) than if they strongly disagree (10%). Among students whose schools do not offer computer science classes, two-thirds (67%) nonetheless say they are interested in learning about the topic if they have role models in computer science, vs. less than half (42%) of those who do not have such role models. The clear influence of role models speaks to the importance of mentoring programs that help students cultivate and stick with their interest in computer science — especially those that target students without access to computer science classes and others who are less likely to already have a computer science role model in their lives.



FINDING 5: Sharing a computer science interest with peers fuels students' intent to study the subject in college.

Regression modeling highlights other factors addressed in the survey that help explain gaps in students' interest in computer science and their plans to pursue that interest beyond high school (while controlling for other factors like students' demographic characteristics). The strongest predictor is students' likelihood to talk about or participate in computer science activities with friends outside of school. Just over four in 10 students (43%) say they do this, including 47% of those in grades five through eight and 40% in grades nine through 12.

Overall, 36% of students who plan to attend college say they would like to study computer science or a related subject. However, this figure rises to two-thirds (67%) among students who talk about, or participate in, computer science-related activities with friends, and drops to 13% among those who do not. This gap is somewhat wider among high school students, at 70% vs. 11%, respectively, than among middle school students (65% vs. 15%, respectively).

The strongest predictor of students' intent to pursue computer science in college is whether or not they talk about or participate in computer science activities with friends outside of school.

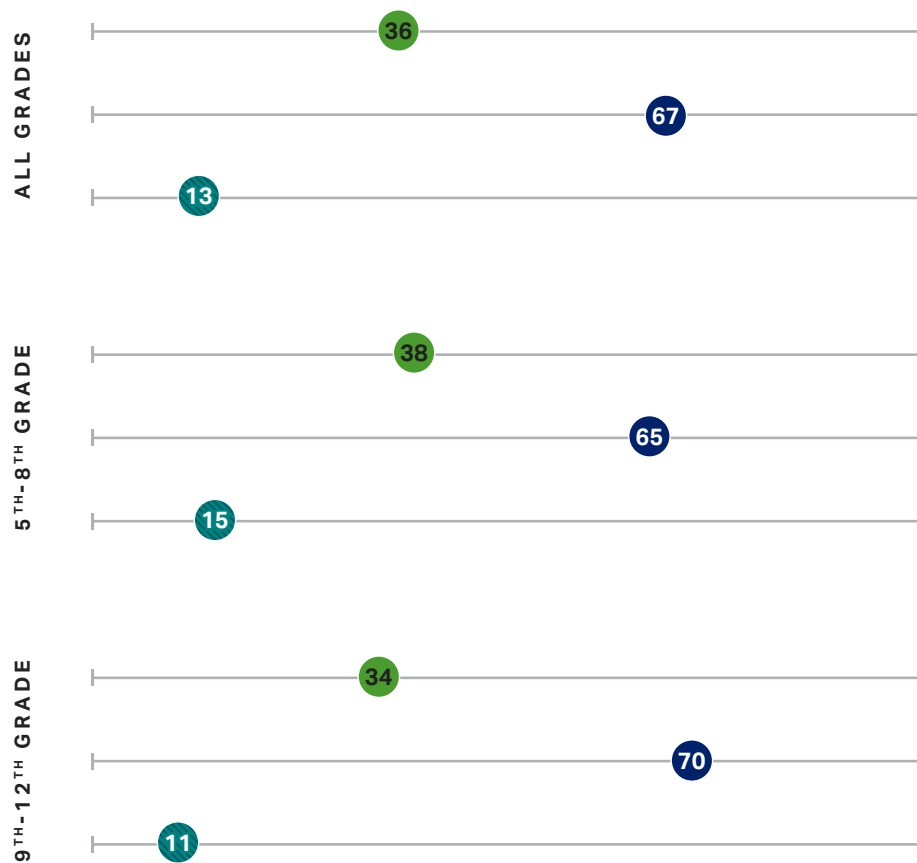
CHART 15

Do you have plans or hope to someday go to college for computer science or a computer science related major?

Among Students Who Plan to Attend College

% Yes

● All students ● Talk to friends about CS outside school ● Do not talk to friends about CS outside school



These findings underscore the value of strategies for connecting students around “extracurricular” computer science activities, including virtually through collaborative software, and physically at venues like camps or clubs, which help enhance students’ interest in computer science through social interactions.

These activities are less common than students' participation in computer science classes (see Chart 10), but they are more strongly linked to students' likelihood to engage with their peers on the topic. While 53% of students who have taken a school-based computer science class say they talk about, or participate in, computer science activities with their friends, this figure rises to more than 70% among those who have learned about computer science in a group or club at school, in an online class outside school, in a community program or activity, or at a camp.

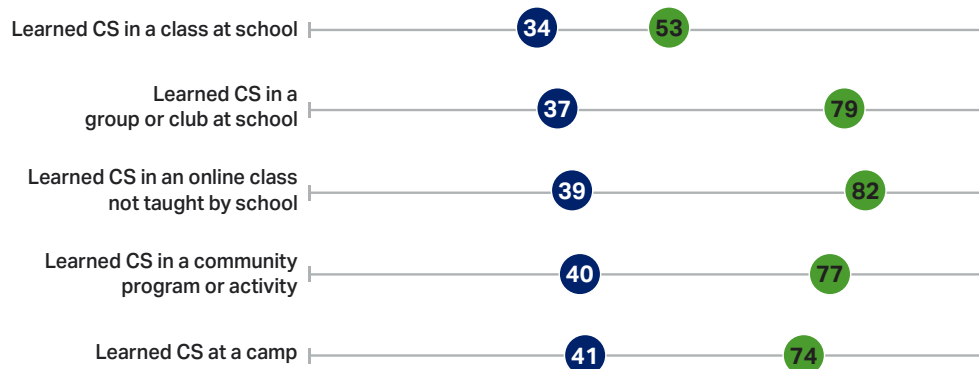
CHART 16

Do you ever talk about or participate in computer science activities with friends outside of school?

Among Students Who Have and Have Not Had Each Computer Science Learning Opportunity

% Yes

● Have had CS learning opportunities ● Have not had CS learning opportunities



Clubs, camps, community programs promote students' likelihood to engage with peers around computer science outside school.

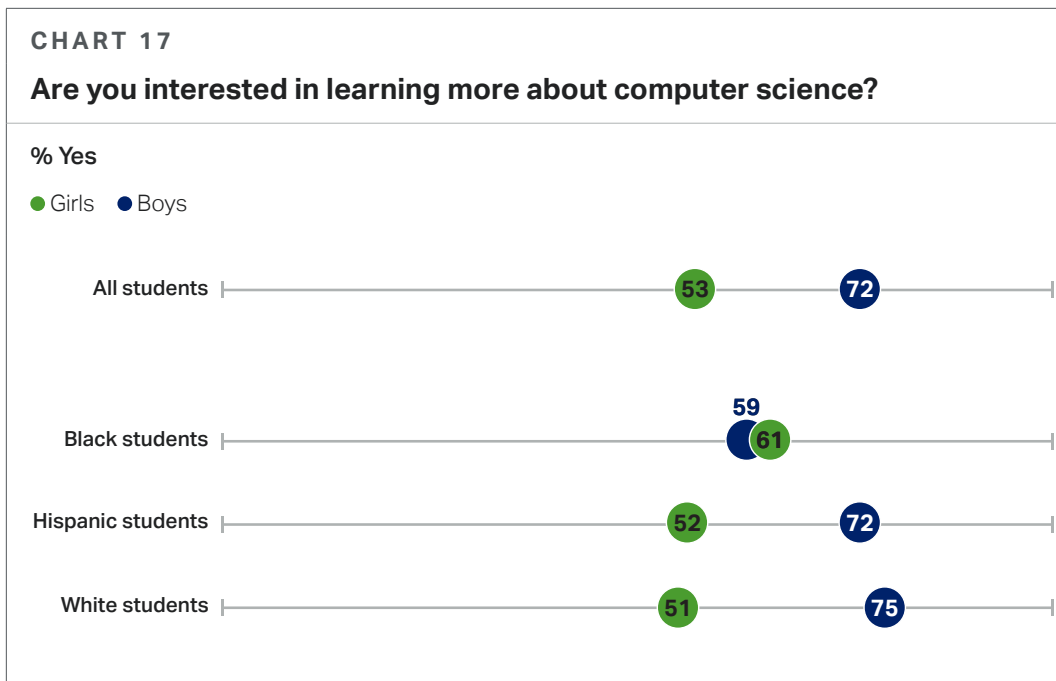


FINDING 6: There remains a sizable gender gap in computer science interest — except among Black students.

The Amazon Future Engineer/Gallup Student Survey confirms and extends previous research on the gender gap in student interest in computer science.²⁵ Overall, 53% of girls say they are interested in learning more about computer science, vs. 72% of boys. Among students who plan to attend college, girls are significantly less likely than boys to say they plan to study computer science (27% vs. 46%). Girls are also less likely than boys to say they would someday like to have a job in a computer science-related field (26% vs. 43%).

However, Black students are a notable exception to this gender gap. Black girls are about as likely as Black boys to say they are interested in learning more about computer science — 61% vs. 59%. Black girls are more likely than White or Hispanic girls to be interested in computer science, while Black boys are less likely than White or Hispanic boys to be interested. Black girls are also more likely than White or Hispanic girls to be interested in computer science-adjacent topics, like how video games, computers and the internet work.

25 Sax et al. (2017). Anatomy of an Enduring Gender Gap: The Evolution of Women's Participation in Computer Science. *Journal of Higher Education*, Vol. 88, Iss. 2, 2017. <https://www.tandfonline.com/doi/abs/10.1080/00221546.2016.1257306?journalCode=uhej20>



Among the many possible factors influencing Black girls' interest in computer science-related topics is the cultural impact of programs like Black Girls CODE and Black Girls Do STEM, which target Black girls in middle and high school with education and skill-building opportunities. The Amazon Future Engineer/Gallup Student Survey finds that Black girls are significantly more likely than White girls to say they talk about or participate in computer science activities with friends outside of school — 44% vs. 30%, respectively.

Notably, however, Black girls' interest in computer science is sharply at odds with their low levels of participation in AP computer science classes. Though participation among all Black students and other underrepresented groups has risen since the introduction of an AP Computer Science Principles (CSP) class geared toward the needs of such groups in 2016,²⁶ in 2020, just 3% of AP CSP test-takers were Black girls and 4% were Black boys.²⁷

That ongoing underrepresentation suggests many schools have an unrealized opportunity to convert elevated interest among Black girls into greater involvement with school-based computer science curricula and sustained academic progress toward computer science as a career option.

26 Jeff Wyatt, Jing Feng, and Maureen Ewing, "AP Computer Science Principles and the STEM and Computer Science Pipelines", <https://apcentral.collegeboard.org/pdf/ap-csp-and-stem-cs-pipelines.pdf?course=ap-computer-science-principles>

27 <https://secure-media.collegeboard.org/digitalServices/pdf/research/2020/National.xlsx>



STUDY IMPLICATIONS

Middle school and high school students overwhelmingly recognize the value of computer science knowledge in the U.S. economy. More than nine in 10 agree that computer science can be used in many different types of jobs (94%), that computer scientists help people (93%) and that they get to help solve important problems (93%).

However, many of those who might otherwise pursue jobs in the field may simply not see the option as available to them. For many rural or low-income students, this may be because their school doesn't teach computer science and they lack role models who demonstrate success in the field. For other students, especially girls, enthusiasm for the topic may be dampened by stereotyping and a lower likelihood to interact with friends in computer science activities.

OF MIDDLE SCHOOL AND HIGH SCHOOL STUDENTS:

94%

agree that computer science can be used in many different types of jobs.

93%

agree that computer scientists help people.

93%

agree that computer scientists get to help solve important problems.

The Amazon Future Engineer/Gallup Student Survey sheds new light on these relationships. It highlights the mismatch between students' interest in computer science and their access to school-based computer science learning opportunities, especially among subgroups from underserved and historically underrepresented communities. In the absence of formal learning opportunities, interest wanes as students grow older. After sixth grade, interest among students in lower-income households falls sharply, from about two-thirds to less than half if their school doesn't offer computer science classes — but interest is largely sustained through high school among such students where classes are available.

These findings underscore the importance of efforts to improve the prevalence and quality of computer science classes, especially in rural environments and among Black and Hispanic students in urban areas. Without such early exposure to the subject, students are less likely to take computer science courses in college — and those who do may be less successful than students who had such experiences.

The Amazon Future Engineer/Gallup Student Survey results also suggest students' interpersonal relationships outside of class can have a powerful influence in reinforcing their interest in the topic and their likelihood to envision themselves pursuing it in college and in the workforce. Interventions that broaden students' access to computer science role models and leverage their peer networks are likely to help inspire and sustain students' curiosity about computers and technology. That interest and social support may, in turn, help more students from all backgrounds chart a course toward secure and fulfilling careers in the field.

METHODOLOGY

Results for the Amazon Future Engineer/Gallup Student Survey are based on a web survey conducted June 2-20, 2021, with a sample of 4,116 U.S. public and private school students in grades 5-12 using a combination of the Gallup Panel, a probability-based panel of U.S. adults, and Dynata opt-in sample. Gallup first secured permission to interview students from a parent/guardian and asked parents/guardians a limited set of questions about the household characteristics before interviewing the selected student. Parents with more than one child in grades five through 12 were instructed to select the child with the most recent birthday to complete the questionnaire.

For results based on the total sample of 4,116 students in grades five through 12, the margin of sampling error is ± 2.0 percentage points.

For results based on the total sample of 1,807 high school students (ninth through 12th grade) the margin of sampling error is ± 2.9 percentage points. For results based on the total sample of 2,309 middle school students (fifth through eighth grade) the margin of sampling error is ± 2.6 percentage points.

For results based on the total sample of 2,577 White students, the margin of sampling error is ± 2.4 percentage points. For results based on the total sample of 546 Black students, the margin of sampling error is ± 5.4 percentage points. For results based on the sample of 713 Hispanic students, the margin of sampling error is ± 4.7 percentage points. For results based on the sample of 107 Asian students, the margin of sampling error is ± 13.3 percentage points.

For results based on the total sample of 2,186 male students, the margin of sampling error is ± 2.7 percentage points. For results based on the total sample of 1,777 female students, the margin of sampling error is ± 3.0 percentage points.

All reported margins of sampling error for the study include the computed design effects for weighting.

Gallup weighted the obtained samples to correct for nonresponse. Nonresponse adjustments were made by adjusting the sample to match the national demographics of gender, grade, race/ethnicity and school type. Demographic weighting targets were based on the U.S. Census Bureau's American Community Survey for 2019.

In addition to sampling error, question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of surveys.

ABOUT AMAZON FUTURE ENGINEER

Amazon Future Engineer is a childhood-to-career computer science education program intended to inspire and educate millions of students from historically underrepresented communities globally, including hundreds of thousands of students in the U.S. each year. Students explore computer science through school curriculum and project-based learning, using code to make music, program robots and solve problems. Additionally, each year, Amazon Future Engineer awards 100 students with four-year, \$40,000 scholarships and paid internships at Amazon and names 10 Teacher of the Year winners, awarding \$30,000 prize packages for going above and beyond to inspire students in computer science and promote diversity and inclusion in the field. For 2021, Amazon Future Engineer has a goal to reach 1.6 million students from historically underrepresented communities globally with real-world-inspired virtual and hands-on computer science project learning. The program is currently available in the U.S., U.K., France and Canada.

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