The University of Texas at Austin

Education Research Center
www.texaserc.utexas.edu

POLICY BRIEF

Algebra I Before High School as a Gatekeeper to Computer Science Participation

Ryan Torbey, Nicole D. Martin, Jayce R. Warner, & Carol L. Fletcher
September 2020

What We Studied

A complex web of factors can influence whether students participate in computer science (CS) during high school. In order to increase participation in CS for all students, we need to better understand who is currently participating and what factors might be hindering participation. This study utilized a large-scale, student-level dataset from the Texas Education Research Center to investigate factors that predict high school student participation in CS and advanced CS courses. Our dataset contained information on over 1.1 million Texas high school students from the 2017-2018 school year, allowing us visibility into CS course availability in schools, student course taking, and detailed demographic information. We used multilevel mixed-effects logistic regression models to explore predictive factors of student participation in CS and advanced CS courses, limiting our analysis to students whose schools offered CS. In both models, our results showed that students who took Algebra I before high school had more than double the odds of being enrolled in a CS course. This work supports and extends previous understanding of factors that are predictive of CS participation in high school, contributing to the existing literature by uncovering the importance of Algebra I before high school as a potential gatekeeper to participation in CS.

In the past decade, there have been several large-scale attempts to measure access to and participation in computer science courses at the high school level [2, 3]. While not inclusive of Texas, the 2018 State of Computer Science Education report found huge gaps in access and participation. This report aggregated state-level participation data from 24 states, reflecting approximately 67% of all public high schools in the United States, to describe issues of equity in access to computer science education [1]. They report a number of important findings regarding equity of access: "Schools in rural communities, schools with higher percentages of underrepresented minority students, schools with higher percentages of students receiving free and reduced lunch, and schools that are Title 1 eligible are less likely to teach computer science" (p. 73). These findings indicate that access to computer science education is not equitably distributed and follows traditional lines of inequity that have existed for decades in education.

Having access to computer science courses is critical for students but does not guarantee that there will be equitable enrollment. Participation in computer science, which is the main focus of this research, has been the subject of few large scale studies. Within schools that offer CS courses, research has shown that there are differences between the schoolwide demographics and the demographics of students who participate in CS coursework. The latest National Survey of Science and Mathematics Education found that less than 30% of enrollment in CS classes was comprised of females and/or students from race/ethnicity groups that are traditionally underrepresented [3]. Notably, this gap extends to higher education as well, with females and underrepresented minority groups less likely to pursue CS degrees in college [5]. Prior research suggests that participation in CS, or the lack thereof, is not necessarily representative of a student's desire to take CS, but a product of institutional and policy structures. Wang and Moghadam [4] found that structural and social barriers resulted in lower participation of female and underrepresented minority students despite high interest in CS.

TEXAS Education
The University of Texas at Austin
College of Education

How We Analyzed the Data

While some factors correlated to the disparities in CS participation are well documented, others have been under little to no investigation. Nuanced understanding of the unique influence and predictive nature of a wide variety of factors that could influence participation is lacking. Further, little is known about how such factors relate to participation in different types of CS courses– specifically, more advanced CS courses. To better understand the factors that can influence whether students participate in CS during high school, we posed the following research questions:

1. What factors predict whether students will enroll in a CS course when available at their school?
2. What factors predict whether students will enroll in an advanced CS course when available at their school?

This study used data from the Texas Education Research Center (Texas ERC). Beginning with data from the 2017-2018 school year, we narrowed our sample by only including students who attended a school that offered one or more CS courses (first model) or one or more advanced CS courses (second model). In the 2017-2018 school year, 1,167,365 students in Texas attended a school that offered at least one CS course. Due to exclusion resulting from missing information, our final samples were 841,717 students in schools with CS and 629,228 students in schools with advanced CS. We defined a subgroup of CS courses as advanced by surveying current and former CS educators in Texas. For each of Texas's 16 CS courses, respondents were asked to rate the level of rigor of the content of each course as low, medium, or high and to answer the question, "Do you consider this an advanced course?" Respondents were provided with a detailed description of the curriculum and standards for each course. Eight qualified educators responded, and through consensus in their ratings, we identified 7 out of the 16 courses as advanced. Participation counts for the courses identified as CS and advanced CS showed that advanced CS courses were more commonly taken in higher grade levels, thus further supporting our categorization. It is important to note that when we discuss access to and participation in CS courses, this is inclusive of advanced CS courses. In other words, we have two categories of courses, but advanced CS is simply a subset of CS, and CS encompasses courses which were found to be advanced as well as courses that were determined to not be advanced.

What We Discovered

Although this study focused on participation in CS, we also investigated the numbers of students who had access to CS and advanced CS courses in order to contextualize our understanding of the issue of participation. In the 2017-18 school year, 43% of public high schools in Texas (approximately 1,610 schools) offered one or more CS courses and 79% of Texas high school students (about 1.1 million students) attended one of these schools that offered CS. The large discrepancy between these two percentages suggests that larger schools (in terms of the number of students enrolled) tend to offer CS courses more often than smaller schools. Additionally, 59% (about 900,000 students) attended a school that offered at least one advanced CS course. Despite the fact that the majority of high school students attended a school that offered CS, the statistics surrounding participation in CS paint a more troubling picture. Only 3.8% of high school students (about 57,000 students) in Texas took a CS course in 2017-2018, and only 1.0% of high school students (about 15,000 students) enrolled in an advanced CS course.

In our first model (Table 2), we sought to identify those factors that predict whether students would enroll in CS courses. Due to space limitations, we will only describe the most relevant results

Table 2: Model 1 Results:
Factors Predicting CS Course Enrollment

Variable Name	Odds Ratio	Std. Err.	z	P>|z|
Algebra before HS	2.01	0.03	54.61	0.00
GT	1.77	0.03	38.17	0.00
Female	0.29	0.00	-100.92	0.00
Eco. Disadv.	0.88	0.01	-8.83	0.00
URM	0.64	0.01	-31.68	0.00
Rural	0.75	0.07	-2.91	0.00
LEP	0.77	0.02	-11.06	0.00
Immigrant	1.01	0.05	0.22	0.83
SPED	0.67	0.02	-15.06	0.00
Total CS courses	1.46	0.05	11.28	0.00
CS Program Length	1.05	0.02	2.19	0.03
Total Students	1.00	0.00	-11.32	0.00
Eco. Dis. Percentage	1.27	0.22	1.37	0.17
Advanced CS	1.10	0.12	0.92	0.36
Constant	0.04	0.01	-18.09	0.00

from each model. The sample for this model included data from 841,717 Texas students across 850 high schools. Logistic regression provides odds ratios, which then can be translated into a percentage change in the odds. By changing the odds ratios into percentage changes in the odds (calculated as the odds ratio minus 1 multiplied by 100), we can better communicate the results of our models. Results showed that, in line with current literature discussed above, economically disadvantaged students, underrepresented minorities (URM, including Black, Hispanic, and Native American students), and females were less likely to enroll in a computer science course.

Specifically, controlling for all other variables in the model, the odds of taking a CS course were decreased by 71.5% for female students in relation to male students, decreased by 36.0% for underrepresented minority students in relation to Asian and White students, and decreased by 11.6% for students who qualified for free or reduced-price lunch in relation to students who did not. Additionally, we found that, controlling for all other variables in the model, students who took Algebra I before high school had double the odds of being enrolled in a CS course than students who did not take Algebra I before high school (+101.5% change in odds).

Our second model (Table 3) examined participation in advanced CS courses as the dependent variable. It included 629,228 students in 517 schools across Texas. Similar to the previous model, female, economically disadvantaged, and underrepresented minority students had lower odds of being enrolled in an advanced CS course. Controlling for all other variables in the model, the odds of taking an advanced CS course were decreased by 74.3% for female students in relation to male students, decreased by 46.9% for underrepresented minority students in relation to Asian and White students, and decreased by 19.7% for students who qualify for free or reduced-price lunch in relation to students who do not. As in our first model, when controlling for all other variables, Algebra I before high school had a large positive percentage change in odds. At a positive change in odds of 157.1%, a student taking Algebra I before high school more than doubles the odds of being enrolled in advanced CS compared to a student who did not take Algebra I before high school.

Table 3: Model 2 Results:
Factors Predicting Advanced CS Course Enrollment

Variable Name	Odds Ratio	Std. Err.	z	P>|z|
Algebra before HS	2.57	0.07	35.65	0.00
GT	2.46	0.07	34.02	0.00
Female	0.26	0.01	-51.37	0.00
Eco. Disadv.	0.80	0.02	-7.04	0.00
URM	0.53	0.02	-21.10	0.00
Rural	0.82	0.11	-1.53	0.13
LEP	0.61	0.04	-7.63	0.00
Immigrant	1.34	0.16	2.55	0.01
SPED	0.55	0.04	-8.73	0.00
Total CS courses	1.25	0.05	5.85	0.00
CS Program Length	1.03	0.03	0.82	0.41
Total Students	1.00	0.00	-5.93	0.00
Eco. Dis. Percentage	1.08	0.25	0.32	0.75
Constant	0.01	0.00	-16.18	0.00

Policy Recommendations

Access to CS. Our research has found that in the 2017-18 school year only 43% of public high schools in Texas (approximately 1,610 schools) offered one or more CS courses. The Texas Education Code governing schools states in *§74.3. Description of a Required Secondary Curriculum* that every high school is required to offer at least one computer science course. This requirement is clearly not being fulfilled by a large number of high schools in the state. Policies targeted at communicating this requirement to school and district leaders as well as policies aimed at enforcing this rule could significantly increase the number of high schools that offer computer science in the state of Texas. Additionally, policymakers should consider investing in professional development for teachers to become certified to teach computer science, expanding the capacity of schools to offer computer science coursework.

Participation in CS. The statistics surrounding participation in CS also point to issues that policymakers should address. Only 3.8% of high school students (about 57,000 students) in Texas took a CS course in 2017-2018, and only 1.0% of high school students (about 15,000 students) enrolled in an advanced CS course. Policymakers in Texas should consider removing the Algebra I prerequisite barriers of entry to introductory computer science courses, specifically Computer Science I, to encourage more widespread enrollment. Additionally, policymakers should consider funding training for school counselors that promotes equitable computer science enrollment practices, such as the National Center for Women and Information Technology's Counselors for Computing program.

The full version of this study can be found at https://doi.org/10.1145/3328778.3366877.

References

[1] Code.org Advocacy Coalition and Computer Science Teachers Association. 2018. 2018 State of computer science education. Report. https://advocacy.code.org/

[2] Gallup Inc. Google Inc. 2016. Trends in the State of Computer Science in U.S. K-12 Schools. Technical Report. http://goo.gl/j291E0

[3] E. M. Gordon and D. J. Heck. 2019. 2018 NSSME+: Status of high school computer science. Report. Horizon Research, Inc.

[4] J. Wang and S.H. Moghadam. 2017. Diversity barriers in K12 computer science education: Structural and social. In SIGCSE Technical Symposium. 615–620.

[5] S. Zweben. 2011. Computing degree and enrollment trends. Report. Computing Research Association.