



# Broadening Participation of Teachers in Computing: Examining Postsecondary Educational Experiences and Prospective Educators' CS Teaching Interests

## RESEARCH

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## ABSTRACT

Teacher shortages in K-12 computer science (CS) education negatively impact students' access to CS courses, exposure to CS concepts, and interest in CS-related careers. To address CS teacher shortages, this study seeks to understand factors related to expressing a preference to teach CS among prospective teachers. The study team analyzed data from 27,700 prospective teacher applications accepted into the 2016–2020 Teach For America (TFA) corps (cohorts). The TFA corps is an alternative teacher development program that recruits and prepares participants to obtain their teaching certification while they work for at least two years in underserved communities on a temporary teaching license. Study results show that earning at least one postsecondary CS credit and majoring in CS are positively associated with these prospective teachers' preference to teach CS. Findings indicate that among these accepted TFA applicants, a larger proportion of male applicants and racially minoritized applicants earned a postsecondary CS credit, majored in CS, and preferred to teach CS compared with female applicants and racially non-minoritized applicants. This study lays the foundation for future explorations of whether early exposure to CS could increase prospective teachers' interest in teaching CS and reduce CS teacher shortages in K-12 settings. Findings from this study can also serve as a precursor to developing policies that result in a CS teacher workforce that is more representative of students enrolled in K-12 public schools.

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## BACKGROUND

### INTRODUCTION

Across the United States, K-12 schools report struggling to hire and prepare computer science (CS) teachers (Shein, 2019). A shortage of K-12 CS teachers can affect the quality of CS instruction offered to students and can leave students without exposure to CS concepts necessary for success in a society that is growing increasingly reliant on computing technology (Gal-Ezer & Stephenson, 2010). There is not only a shortage of K-12 CS teachers, but the current CS teacher workforce also has a lack of racial and gender diversity, with 75% of CS teachers identifying as White and 65% identifying as female (Koshy et al., 2021). This CS teacher shortage is partially driven by factors including a small number of teachers graduating with a CS degree (Shein, 2019), noncompetitive teacher salaries (Shein, 2019), the cost of pursuing postsecondary education, limited preservice CS teacher pathways (Gal-Ezer & Stephenson, 2010; Kim et al., 2021), and the non-compulsory nature of CS courses (Code.org, CSTA, & ECEP Alliance, 2021). Teacher shortages and the lack of a teacher workforce that is representative of students may harm students' likelihood of identifying with and pursuing careers in CS (Dasgupta & Stout, 2014; Fields et. al., 2018; Gallup & Amazon, 2021; Moudgalya et al., 2021).

How should policymakers and practitioners address this CS teacher shortage and recruit a diverse CS workforce? To explore factors related to recruiting a diverse CS teacher workforce, the study team retrospectively analyzed CS teaching preference, postsecondary major, CS postsecondary course credit data, and select demographic information from applicants accepted to Teach For America (TFA) for participation in cohorts (or "corps") between 2016 to 2020. The purpose of this analysis is to better understand factors related to expressing a preference to teach CS. Findings from this study can serve as a precursor to developing policies that result in a CS teacher workforce that is more representative of students enrolled in K-12 public schools.

This paper begins by discussing the significance of CS skills for K-12 students and the critical role teachers play for developing interest in CS-related careers, especially for racially minoritized (Black, Latinx, and Indigenous) students, female students, and students with intersections of those identities. We go on to describe the study's key research questions, measures, sample, data collection procedures, analysis methods, and results. Lastly, the paper presents a discussion of findings and considerations for next steps.

### THE NECESSITY OF CS FOR K-12 STUDENTS

CS skills have become essential to students' professional (Clotfelter, Ladd, & Vigdor 2007; Flèche, 2017), academic

(College Board, 2015; Darling-Hammond, 1997; Hanushek, Rivkin, & Kain, 1998; Sanders & Horn, 1998; Toropova, Johansson, Myberg, 2019), and personal success (Chetty, Friedman, & Rockoff, 2014; Flèche, 2017). Programming, algorithmic thinking, analytic reasoning, mobile application development, and data analysis are among the top skills that employers seek and are critical to modern-day communications and infrastructure (LinkedIn, 2020; Vee, 2013). There is also substantial market demand for workers to possess CS skills; CS-related employment has been projected to increase by 13% from 2020 to 2030 (U.S. BLS, 2021). As market demand surges, the supply of workers with CS skills is failing to meet the growing demand; there were more than one million job vacancies in CS-related occupations in the United States during 2021, an 11% increase from 2020 (The Hechinger Report, 2021).

Not only are CS skills essential to meeting market demand, but they are crucial to developing students' technological literacy and improving their academic achievement. Because computing technology has become an integral part of daily life, students need CS skills to meaningfully engage in society. Learning CS skills requires problem solving and critical thinking that are fundamental to whole-child learning (Diamond, 2010). Moreover, students who learn CS in Grades K-12 are more likely to demonstrate improvement in creativity, mathematical and spatial skills (College Board, 2015; Salac et al., 2021), metacognition, reasoning skills (Scherer, Siddiq, & Viveros, 2019), and science achievement (Century, Ferris, & Zuo, 2020). Increasing students' interest in CS will help our society meet the demand for workers with CS skills and develop students' ability to navigate an increasingly computational society.

### THE CRITICAL ROLE OF K-12 CS TEACHERS

Teachers play a crucial role in developing students' academic and career interests and are a gateway to exposing students to new subjects, especially in STEM and CS domains (Federici, Caspersen, & Wendelborg, 2016; Tambunan, 2018; Gallup & Amazon, 2021). Previous studies have also found that students' primary exposure to CS topics is from K-12 teachers and occurs during school hours (Gallup & Amazon, 2021; Google Inc. & Gallup, 2015a; Sadler et al., 2014). Moreover, students who receive CS instruction are more likely to become interested in CS (Fields et al., 2018) and major in CS during postsecondary education compared to their peers who do not receive such instruction (Code.org, 2016; Code.org, CSTA, & ECEP Alliance, 2021; Dougherty, Mellor, & Jian, 2006; Mattern, Shaw, & Ewing, 2011; Lee & Mamerow, 2019; Yadav et al., 2016).

Given the relationship between exposure to CS and interest in CS-related careers, increasing the amount of CS teachers and CS instruction in under-resourced schools

that predominately serve racially minoritized students is critical to expanding and diversifying the CS workforce, including the number of K-12 CS teachers. Disparities in access to CS instruction persist along traditional lines of inequity. Schools that primarily serve Black, Latinx, and Indigenous students are less likely to offer CS instruction compared with well-resourced schools serving predominately White students (Goode, 2007; Goode, 2008; Google Inc. & Gallup Inc., 2016a; Margolis et al., 2003). When schools do offer CS courses, they are often advanced courses whose enrollment of Black, Latinx, Indigenous, and female students (and students with intersections of those identities) is significantly lower than it is for the general student population (Code.org, CSTA, & ECEP Alliance, 2021; Wang et al., 2016). A dearth of Black, Latinx, and Indigenous CS teacher role models also impacts female and racially minoritized students' exposure to CS and interest in CS subjects (Google Inc. & Gallup Inc., 2016a; Goode, 2008). When students see role models in CS with their same background, they are more likely to visualize themselves in CS fields and feel a sense of belonging, which are both strongly correlated with interest in CS (Dasgupta & Stout, 2014; Gallup & Amazon, 2021; Moudgalya et al., 2021). The unequal participation in and exposure to CS among Black, Latinx, Indigenous, and female students throughout K-12 schools contributes to an underrepresentation of these groups majoring in CS throughout postsecondary education (Richardson et al., 2019; Sax et al., 2022).

Teachers – especially Black, Latinx, and Indigenous teachers – play a critical role in exposing students to CS concepts and developing their interests in CS-related careers. **To help broaden K-12 students' exposure to CS instruction, this study seeks to identify factors that are related to prospective teachers' preference to teach CS.**

## STUDY CONTEXT

To identify factors related to recruiting CS teachers, TFA provided select application data from its teacher corps program to the study team. TFA is an alternative teacher development program that recruits and prepares participants to obtain their teaching certification while they commit to work for two years in underserved communities on a temporary teaching license. TFA provides corps members with formal training, coaching, and professional development while they work toward their full teaching certification.<sup>1</sup> To join the TFA corps, interested participants must have a bachelor's degree, a minimum cumulative undergraduate GPA of 2.5 on a 4.0 scale, and authorization to work legally in the United States. Interested participants must submit an application containing postsecondary

transcripts, a cover letter, and responses to a structured questionnaire. TFA applicants also reported their racial/ethnicity and gender identity on their application.

## RESEARCH QUESTIONS

To guide our inquiry, the study team established the following research questions (RQs) for this study:

**RQ1.** What is the relationship between CS teaching preference and earning a post-secondary CS credit among accepted TFA corps applicants from 2016–2020 cohorts?

**RQ2.** What is the relationship between CS teaching preference and majoring in CS during post-secondary education among accepted TFA corps applicants from 2016–2020 cohorts?

**RQ3.** What is the relationship between CS teaching preference and gender identity among accepted TFA corps applicants from 2016–2020 cohorts?

**RQ4.** What is the relationship between CS teaching preference and race/ethnicity among accepted TFA corps applicants from 2016–2020 cohorts?

## METHODS AND DATA COLLECTION

### MEASURES

As part of the TFA corps application, applicants were required to submit their postsecondary transcripts and respond to a structured application questionnaire.<sup>2</sup> TFA transcribed data from application materials for the 2016–2020 corps cohorts into an analysis data set and transmitted the data set to the study team. The analysis data set contained data on all accepted TFA corps applicants' postsecondary CS credits, postsecondary major, CS teaching preference, racial/ethnic identity, Pell grant recipient status, and gender identity. To prepare the data for analyses, the study team constructed a binary outcome measure of CS preference and multiple independent variables, including postsecondary CS credits, postsecondary major, racial identity, and gender identity (described in Table 1).

### STUDY SAMPLE

This study analyzes data from applicants accepted into the TFA program for corps years ranging from 2016 to 2020 (N = 27,700). The demographics of the study sample are displayed in Table 2. Of those in the overall sample, 74%

MEASURE	DEFINITION
CS teaching preference	CS teaching preference is the binary outcome measure of whether applicants expressed a teaching preference. It is coded as “1” if the accepted TFA applicant indicated that they “preferred” or “strongly preferred” to teach CS and “0” if the applicant selected that teaching CS was “less preferred.”
Postsecondary CS credits earned	For analysis, the study team recoded the number of postsecondary CS credits earned by accepted TFA applicants into a binary indicator. It is coded as “1” if the applicant earned at least one postsecondary CS credit and “0” if not.
Postsecondary CS major	The study team created a binary variable for postsecondary CS major. It is coded as “1” if accepted applicants had a postsecondary CS major and “0” if they did not.
Racial/Ethnic identity	TFA provided the study team with data on accepted applicants’ racial/ethnic identity. On the questionnaire submitted to TFA, applicants were able to select “African American, Black (Non-Hispanic)”; “Alaska Native”; “American Indian”; “Asian American or Pacific Islander (Non-Hawaiian)”; “Latino or Hispanic”; “Multiethnic/Multiracial”; “Native Hawaiian”; “Other (I identify as a person of color)”; “Other (I do not identify as a person of color)”; or “White, Caucasian (Non-Hispanic).” Because there were low cell sizes for certain racial groups, the study team included a single binary variable coded “1”, representing “racially/ethnically minoritized” for those who selected “Alaska Native”, “Asian American or Pacific Islander (Non-Hawaiian)”, “African American, Black (Non-Hispanic)”, “Native Hawaiian”, “American Indian”, “Multiethnic/Multiracial”, “Latino or Hispanic”; or “Other (I identify as a person of color)” and “0”, representing “racially/ethnically non-minoritized”, for those who selected “White, Caucasian (Non-Hispanic)” or “Other (I do not identify as a person of color).” <sup>3</sup> The study team included this indicator as a binary variable with an omitted, or reference, category of “non-minoritized.”
Gender identity	When completing the TFA corps application, applicants were asked to disclose their gender identity. Applicants were able to select “Male,” “Female,” or “Other.” The study team included this indicator as a polytomous categorical variable with an omitted, or reference, category of female.
Pell grant recipient status	When completing the TFA corps application, applicants were asked to disclose if they had received a Pell grant during their postsecondary education. <sup>4</sup> This indicator was included as a binary variable with “1” representing “Yes” and “0” representing “No.” The study team included this indicator as a categorical variable with an omitted, or reference, category of “No.”
Application year	The study team also included a categorical measure of application year (2016–2020) as a covariate in model. In the statistical model, the year 2016 was the omitted, or reference, category.

**Table 1** Study Measures.

were female, 50% were White, 77% did not earn at least one postsecondary CS credit, only 0.5% majored in CS during postsecondary education, and 92% preferred not to teach CS (see *Figure 1*). All TFA applicants reported their postsecondary major, postsecondary credits, Pell grant recipient status, and CS teaching preference. Some TFA applicants did not report their gender identity or racial/ethnic identity; those applicants who were missing data for gender identity or racial/ethnic identity were excluded from multiple logistic regression analysis, yielding a smaller analytic sample for that analysis ( $n = 27,615$ ). For additional figures describing the sample, please consult Appendix B. For additional tables describing the sample, please refer to Appendix C.

## ANALYSIS PLAN

### Cross-tabulation and descriptive analyses

To answer research questions (RQs) 1–4, the research team first calculated the relative frequency distributions of accepted TFA corps applicants’ preference to teach CS for those applicants who did and did not earn postsecondary CS credits (RQ1) and for those applicants who did and did not major in CS during postsecondary education (RQ2). Among accepted TFA corps applicants from the 2016–2020 cohorts, the study team calculated relative frequency distributions by gender identity and then by racial/ethnic

identity for those applicants who did and did not prefer to teach CS (RQs 3 & 4).

### Multiple logistic regression models

To supplement the findings from the cross-tabulations, the research team also used a multiple logistic regression model to predict preference to teach CS. The multiple logistic regression model used in this study can be represented by the follow equation:

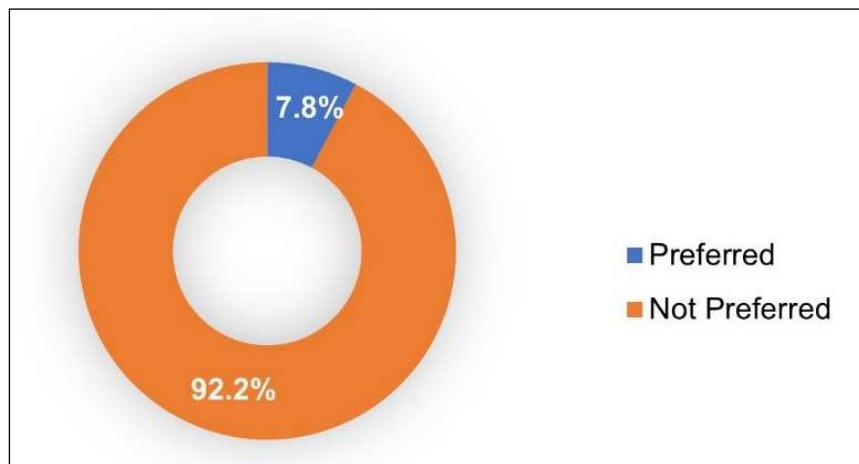
$$\text{logit}(Y_i) = \beta_0 + \beta_1 \text{CScredits}_i + \beta_2 \text{CSmajor}_i + \beta_3 X_i$$

$Y_i$  is a binary indicator of preference to teach CS for TFA accepted applicant  $i$ , coded “1” to indicate a preference and “0” to indicate no preference.  $\text{CScredits}_i$  is a binary indicator of any postsecondary CS credits for TFA accepted applicant  $i$ ,  $\text{CSmajor}_i$  is a binary indicator of a postsecondary CS major for TFA accepted applicant  $i$ . The vector  $X_i$  represents the applicant-level characteristics (race/ethnicity, gender, Pell grant status, application year). The coefficient  $\beta_1$  represents the change in the expected log odds for those who earned postsecondary CS credit relative to those who did not, holding all other predictors constant. The coefficient  $\beta_2$  represents the change in the expected log odds for those who had a CS major relative to those who did not, holding all other predictors constant.

GROUP	2016		2017		2018		2019		2020		OVERALL	
	N	% OF YEAR	N	% OF YEAR								
<b>Gender Identity</b>												
Male	1,400	25.7%	1,449	25.7%	1,540	25.0%	1,451	26.1%	1,198	24.6%	7,038	25.4%
Female	3,984	73.0%	4,130	73.2%	4,534	73.6%	4,024	72.3%	3,571	73.2%	20,243	73.1%
Other	13	0.2%	21	0.4%	33	0.5%	22	0.4%	48	1.0%	137	0.5%
Did not report Gender	57	1.0%	43	0.8%	53	0.9%	70	1.3%	59	1.2%	282	1.0%
<b>Racial/Ethnic Identity</b>												
African American, Black (Non-Hispanic)	1,110	20.4%	985	17.5%	1,152	18.7%	1,051	18.9%	849	17.4%	5,147	18.6%
Alaska Native	0	0.0%	1	0.0%	1	0.0%	3	0.1%	1	0.0%	6	0.0%
American Indian	34	0.6%	25	0.4%	27	0.4%	36	0.6%	27	0.6%	149	0.5%
Asian American or Pacific Islander (Non-Hawaiian)	345	6.3%	396	7.0%	490	8.0%	482	8.7%	410	8.4%	2,123	7.7%
Latino or Hispanic	756	13.9%	770	13.6%	828	13.4%	795	14.3%	776	15.9%	3,925	14.2%
Multiethnic/ multiracial	353	6.5%	343	6.1%	388	6.3%	360	6.5%	357	7.3%	1,801	6.5%
Native Hawaiian	5	0.1%	11	0.2%	10	0.2%	10	0.2%	6	0.1%	42	0.2%
White, Caucasian (Non-Hispanic)	2,599	47.7%	2,863	50.7%	3,014	48.9%	2,635	47.3%	2,284	46.8%	13,395	48.4%
Other—I do not identify as a person of color	48	0.9%	61	1.1%	58	0.9%	46	0.8%	27	0.6%	240	0.9%
Other—I identify as a person of color	98	1.8%	124	2.2%	133	2.2%	84	1.5%	76	1.6%	515	1.9%
Did not report racial/ethnic identity	106	1.9%	64	1.1%	59	1.0%	65	1.2%	63	1.3%	357	1.3%
<b>CS teaching preference</b>												
Preferred	472	8.7%	467	8.3%	492	8.0%	411	7.4%	325	6.7%	2,167	7.8%
Not Preferred	4,982	91.3%	5,176	91.7%	5,668	92.0%	5,156	92.6%	4,551	93.3%	25,533	92.2%
<b>Received Pell grant?</b>												
Yes	2,499	45.8%	2,362	41.9%	2,607	42.3%	2,294	41.2%	2,155	44.2%	11,917	43.0%
No	2,955	54.2%	3,281	58.1%	3,553	57.7%	3,273	58.8%	2,721	55.8%	15,783	57.0%
<b>Obtained postsecondary CS major?</b>												
Yes	8	0.1%	22	0.4%	35	0.6%	33	0.6%	35	0.7%	133	0.5%
No	5,446	99.9%	5,621	99.6%	6,125	99.4%	5,534	99.4%	4,841	99.3%	27,567	99.5%
<b>Earned postsecondary CS credit?</b>												
Yes	1,281	23.5%	1,270	22.5%	1,357	22.0%	1,309	23.5%	1,178	24.2%	6,395	23.1%
No	4,173	76.5%	4,373	77.5%	4,803	78.0%	4,258	76.5%	3,698	75.8%	21,305	76.9%
<b>Total</b>	5,454	100.0%	5,643	100.0%	6,160	100.0%	5,567	100.0%	4,876	100.0%	27,700	100.0%

**Table 2** Characteristics of Study Sample: Accepted TFA Applicants for 2016–2020 Cohorts (N = 27,700).

Note: Data were generated by Teach For America (TFA) by transcribing TFA corps application materials from accepted applicants from 2016–2020 TFA corps cohort years. N = 27,700; some accepted applicants did not report their gender identity or racial/ethnic identity, and thus, these cases were excluded from some analyses. All applicants reported their CS teaching preference, post-secondary major, and CS credits earned. Percentages in this table should be interpreted as the proportion of the total sample belonging to each group within each application year. CS = computer science.



**Figure 1** CS Teaching Preference Among Accepted TFA Corps Applicants (2016–2020).

Note: Data were generated by Teach For America (TFA) by transcribing TFA corps application materials from cohorts years 2016–2020.  $N = 27,700$ ; all accepted TFA applicants responded. Percentage values may not equal 100% due to rounding. CS = computer science.

Since the dependent variable of interest was binary (i.e., applicants either preferred or did not prefer teaching CS), and there were multiple independent variables of interest, multiple logistic regression was an appropriate analysis approach. Pairwise deletion was applied to the analysis, resulting in the exclusion of cases that did not have valid data on variables of interest (e.g., gender identity and racial/ethnic identity). All TFA corps applicants reported their postsecondary major, postsecondary credits earned, Pell grant status, and CS teaching preference. A total of 27,418 TFA applicants reported their racial/ethnic identity and a total of 27,343 TFA applicants reported their gender identity. After removing applicant cases which did not contain data on gender or racial/ethnic identity, a total of 27,165 accepted applicants remained in the multiple logistic regression analytic sample. When describing results of the multiple logistic regression model, the study team uses odds ratios and predicted probabilities. To calculate odds ratios, the research team exponentiated each estimated coefficient from the logistic regression model. To aid in interpretation of results, the research team also presents the predicted probabilities of preferring to teach CS for each level of the independent variables of interest while holding all other independent variables and covariates in the model at their means.

## RESULTS

### RQ1. WHAT IS THE RELATIONSHIP BETWEEN CS TEACHING PREFERENCE AND EARNING A POST-SECONDARY CS CREDIT AMONG ACCEPTED TFA CORPS APPLICANTS FROM 2016–2020 COHORTS?

Descriptive analysis results show that the proportion of those accepted applicants who preferred to teach

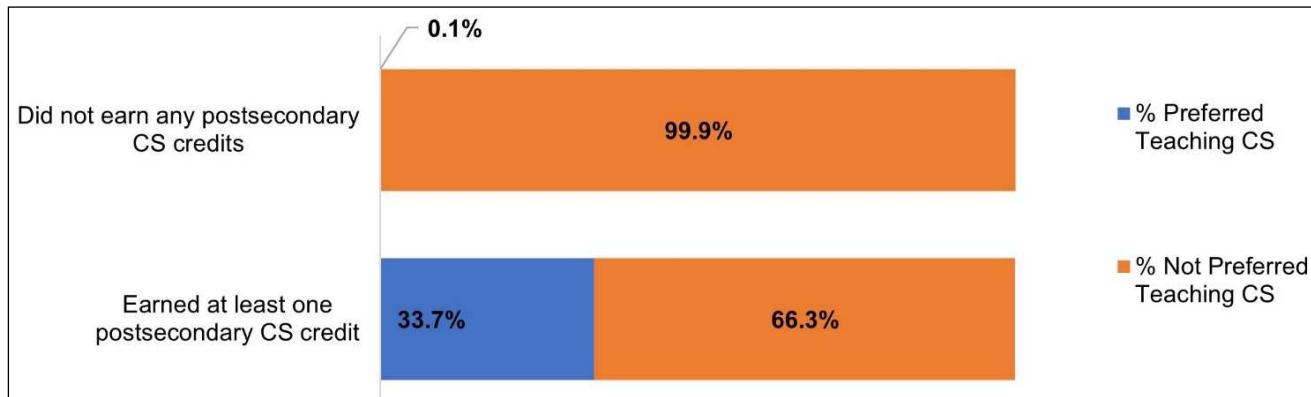
CS is greater among those who earned at least one postsecondary CS credit (33.7%) than among those who did not earn at least one postsecondary CS credit (.1%); see [Figure 2](#). For a table describing the data, please refer to Table A1 in Appendix A.

Analysis results from the multiple logistic regression model demonstrate that, while holding all other variables in the model constant, the odds of preferring to teach CS are approximately 714 times higher for those who did earn a post-secondary CS credit compared to those who did not earn a post-secondary CS credit (see Table A2); while holding all other independent variables and covariates in the model at their means, this translates to a predicted probability of approximately .33% for those who did not earn a post-secondary CS credit and approximately 70% for those who did earn a post-secondary CS credit (see Table A3).

### RQ2. WHAT IS THE RELATIONSHIP BETWEEN CS TEACHING PREFERENCE AND MAJORING IN CS DURING POST-SECONDARY EDUCATION AMONG ACCEPTED TFA CORPS APPLICANTS FROM 2016–2020 COHORTS?

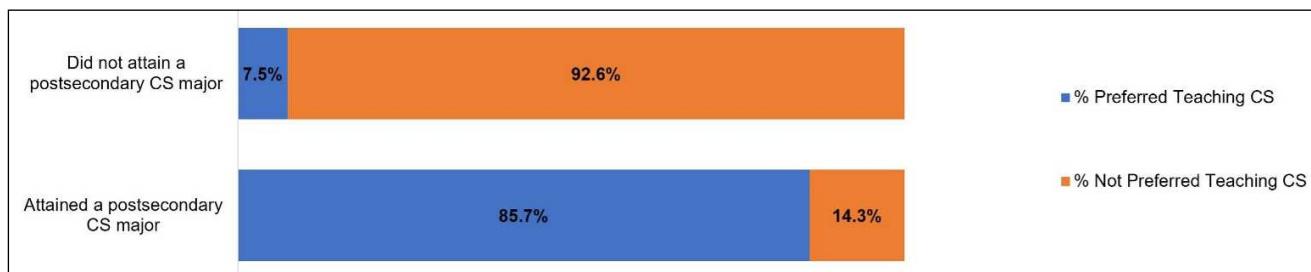
Descriptive analysis results show that the proportion of those accepted applicants who preferred to teach CS is greater among those who majored in CS during their postsecondary education (85.7%) than among those who did not major in CS during their postsecondary education (7.4%); see [Figure 3](#). For tables describing the data, please refer to Table A4 in Appendix A.

Analysis results from the multiple logistic regression model demonstrate that, while holding all other variables in the model constant, the odds of preferring to teach CS are roughly 26 times higher for those who had a post-secondary CS major compared to those who did not have a post-secondary CS major (see Table A2); while holding all



**Figure 2** Accepted TFA Applicants' CS Teaching Preference by Postsecondary Credit Attainment (2016–2020).

Note: Data were generated by Teach For America (TFA) by transcribing TFA corps application materials from cohort years 2016–2020. N = 27,700; all accepted TFA applicants responded. The percentage of those who did not earn any CS credit and preferred to teach CS is equal to 0.1%. Percentage values may not equal 100% due to rounding. CS = computer science.



**Figure 3** Accepted TFA Applicants' CS Teaching Preference by Postsecondary CS Major Attainment (2016–2020).

Note: Data were generated by Teach For America (TFA) by transcribing TFA corps application materials from cohort years 2016–2020. N = 27,700; all accepted TFA applicants responded. Percentage values may not equal 100% due to rounding. CS = computer science.

other independent variables and covariates in the model at their means, this translates to a predicted probability of approximately 31% for those TFA applicants who majored in CS during their postsecondary education and approximately 2% for those TFA applicants who did not major in CS during their postsecondary education (see Table A5).

### **RQ3. WHAT IS THE RELATIONSHIP BETWEEN CS TEACHING PREFERENCE AND GENDER IDENTITY AMONG ACCEPTED TFA CORPS APPLICANTS FROM 2016–2020 COHORTS?**

Among accepted TFA corps applicants from 2016–2020 cohorts, the proportion of males who preferred to teach CS (12.3%) is greater than that of females (6.2%); see Figure 4. For a table describing the data, please refer to Table A6 in Appendix A.

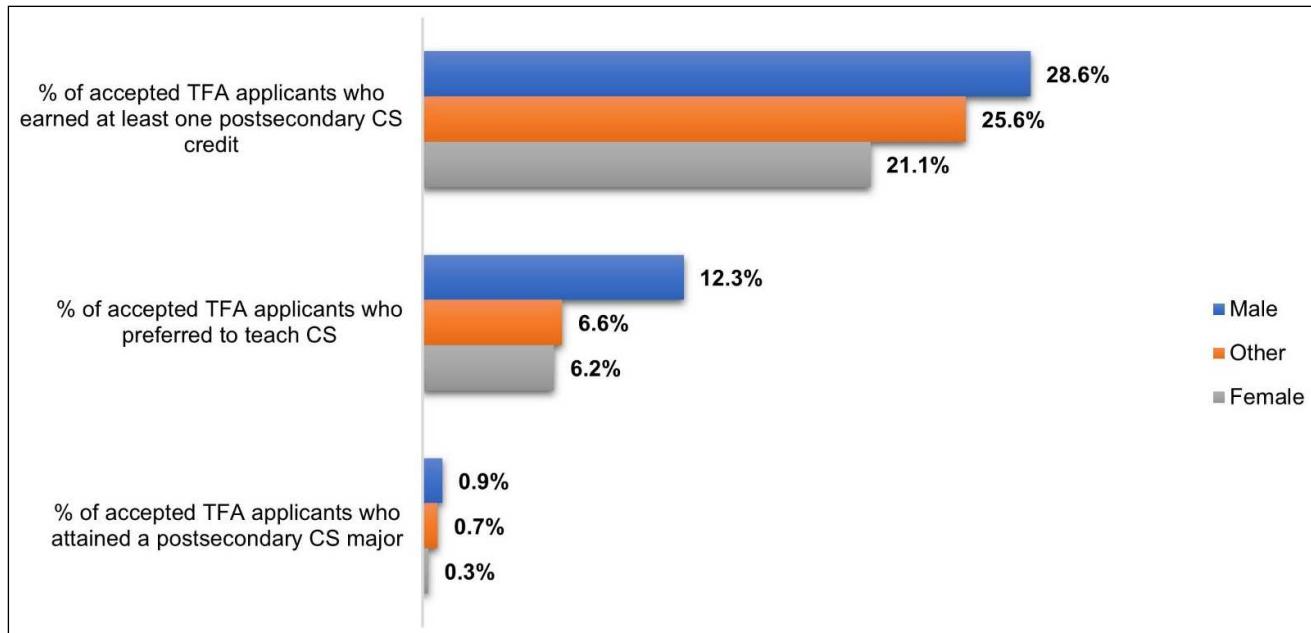
Analysis results from the multiple logistic regression model demonstrate that, while holding all other variables in the model constant, the odds of preferring to teach CS are about twice as high for those who identify as male compared to those who identify as female (see Table A2); while holding all other independent variables and covariates in the model at their means, this translates to a predicted probability of approximately 12% for those TFA

applicants who identify as male and approximately 7% for those TFA applicants who identify as female (see Table A7).

### **RQ4. WHAT IS THE RELATIONSHIP BETWEEN CS TEACHING PREFERENCE AND RACE/ETHNICITY AMONG ACCEPTED TFA CORPS APPLICANTS FROM 2016–2020 COHORTS?**

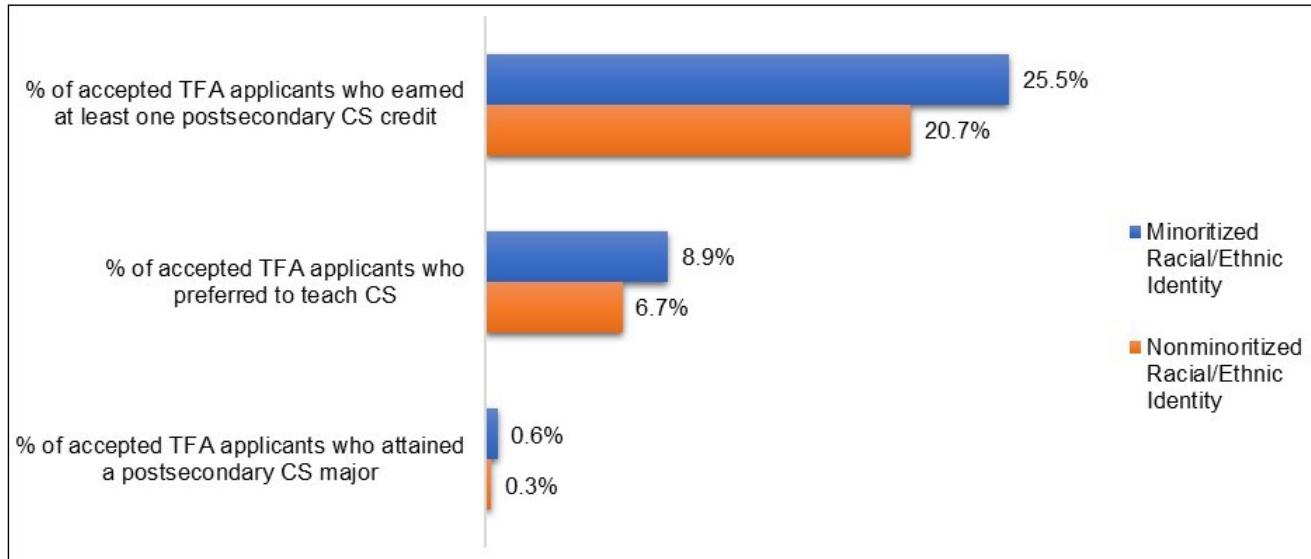
Among accepted TFA corps applicants from 2016–2020 cohorts, the racial/ethnic group with the largest proportion of accepted applicants who preferred teaching CS was Alaska Native (16.7%), followed by Asian American or Pacific Islander (11.7%), African American or Black (9.7%), Native Hawaiian (9.5%), American Indian (9.4%), Other (I identify as a person of color; 8.0%), Multiracial/Multiethnic (7.7%), Other (I do not identify as a person of color; 7.5%), Latino or Hispanic (6.9%), and White (6.7%). Racially/Ethnically minoritized accepted applicants had a greater proportion of those who preferred teaching CS (8.9%) compared with racially/ethnically non-minoritized applicants (6.7%); see Figure 5. For tables describing the data, please refer to Tables A8 and A9 in Appendix A.

Analysis results from the multiple logistic regression model demonstrate that, while holding all other variables in the model constant, the odds of preferring to teach



**Figure 4** Percentage of accepted TFA Corps Applicants by Response Type and Gender Identity (2016–2020).

Note: Data were generated by Teach For America (TFA) by transcribing TFA corps application materials from accepted applicants in cohort years 2016–2020.  $n = 27,418$ ; the number of accepted TFA applicants in this table does not equal the total number of TFA accepted applicants from cohort years 2016–2020 ( $N = 27,700$ ) since not all accepted applicants reported their gender identity. Percentage values may not equal 100% due to rounding. CS = computer science.



**Figure 5** Percentage of Accepted TFA Applicants by Response Type and Racial/Ethnic Identity (2016–2020).

Note: Data were generated by Teach For America (TFA) by transcribing TFA corps application materials from cohort years 2016–2020.  $n = 27,343$ ; the number of accepted TFA applicants in this figure does not equal the total number of TFA accepted applicants from cohort years 2016–2020 ( $N = 27,700$ ) since not all accepted applicants reported their racial/ethnic identity. Percentage values in this figure should be interpreted as the proportion of each racial/ethnic group that earned at least one postsecondary credit, the proportion of each racial/ethnic group that preferred to teach computer science (CS), and the proportion of each racial/ethnic group that obtained a postsecondary CS major, respectively. Percentage values are rounded to the nearest 10th decimal and may not equal 100% due to rounding. CS = computer science.

CS were 1.14 times higher among those TFA applicants who identified as part of a minoritized racial/ethnic group compared to those TFA applicants who identified as part of a non-minoritized racial/ethnic group (see Table A2); while holding all other independent variables and covariates in the model at their means, this translates to a predicted probability of about 9% for those TFA applicants who identified as part of a racially/ethnically minoritized group and approximately 8% for those TFA applicants who identified as part of a racially/ethnically non-minoritized group (see Table A10).

## DISCUSSION AND IMPLICATIONS

Study findings indicate that earning at least one postsecondary CS credit and majoring in CS during postsecondary education are two factors positively related to these prospective teachers' preference to teach CS. In addition, this study found that among accepted TFA applicants from 2016–2020, a smaller proportion of female accepted applicants earned at least one postsecondary CS credit, majored in CS during their postsecondary education, and preferred to teach CS compared with male accepted applicants. This study also found that a larger proportion of those applicants from racially/ethnically minoritized groups preferred to teach CS, earned at least one postsecondary CS credit, and majored in CS during their postsecondary education compared with applicants who identify with a racially/ethnically non-minoritized group.

The positive relationship between expressing a preference to teach CS and earning postsecondary CS credits suggests a possible pathway for increasing the numbers of teachers who are interested in CS teaching positions. Because the study design is not appropriate for making causal inferences, future research using an experimental design with random assignment to CS coursework would be needed before making any policy recommendations.

Implications from this study's findings are discussed in the next section. The discussion is broken down into subsections by research question. Each subsection first examines key findings, then presents considerations for next steps based on the study's results, and lastly highlights current examples of suggested considerations.

### RELATIONSHIPS BETWEEN CS TEACHING PREFERENCE, EARNING POSTSECONDARY CS CREDITS, AND CS MAJOR (RQS 1 & 2)

#### Key findings

This study provides initial evidence that earning a postsecondary CS credit or majoring in CS are correlated with TFA applicants' preference to teach CS. Other studies

have demonstrated that exposure to K-12 CS instruction significantly impacts students' interest in CS (Gallup & Google, 2020; Lambert & Guiffre, 2009), their perceptions of CS as important (Google & Gallup, 2020), their intention to major in CS during college (Code.org, 2016; Code.org, CSTA, & ECEP Alliance, 2021; Mattern, et al., 2011; Sax et al., 2022; Yadav et al., 2016), their confidence in learning CS (Amelink et al., 2018; Govender & Basak, 2015), their feelings of belonging in CS (Moudgalya et al., 2021), and their decision to pursue a CS-related career (Sax et al., 2022). Furthermore, prior research indicates that the vast majority of in-service CS teachers earned at least one college-level CS credit (Koshy et al., 2021; Outlier Research & Evaluation, 2016). Given these prior findings, it is unsurprising that our study found a positive relationship between postsecondary CS instructional exposure and preference for teaching CS among accepted TFA applicants from 2016–2020. The results of this study build on previous literature to support the idea that exposure to CS instruction among prospective teachers is not only related to general interest in CS but also extends to interest in teaching CS.

#### Considerations and examples

*Consideration 1: Explore requiring CS coursework in postsecondary education for teachers on alternative certification pathways.*

Given this study's findings on the relationship between earning at least one postsecondary CS credit and preference for teaching CS, future research should investigate whether there is a causal relationship between CS coursework and CS teaching preferences. Future studies could establish a causal link by randomly assigning preservice teachers or teachers in alternative certification pathways to take a CS course during their postsecondary education. If experimental research indicates a positive impact of CS coursework, TFA and alternative teacher development pathways might consider exposing their participants to CS by requiring that they take at least one CS credit in their postsecondary education. In addition, future research could explore whether professional development—as opposed to CS coursework in postsecondary education—is also causally linked to an increased preference to teach CS. If this is the case, alternative certification programs could consider implementing high quality professional development to attract more teachers into CS teaching positions. An example of a teacher preparation program that attempts to bolster the CS teacher workforce by tapping into existing STEM majors and prospective teachers in other subjects is the UTeach program started at the University of Texas at Austin. UTeach offers a low-cost and accessible CS teaching pathway for any undergraduate student to

add a CS teaching certification to their degrees in under a year.<sup>5</sup> This program provides students with self-paced CS certification preparation materials and requires students to complete a short sequence of two 35 to 55-hour-long CS teacher preparation courses. By offering an affordable, accessible, and structured pathway to become certified to teach CS without adding time or cost to attaining a postsecondary degree, the UTeach program exposes STEM students to the teaching profession early in their postsecondary education and removes common barriers to obtaining a certification to teach CS and other STEM subjects (Baches et al., 2018; Hughes et al., 2020).

### **GENDER DIFFERENCES IN POSTSECONDARY CS CREDITS, POSTSECONDARY CS MAJOR, AND CS TEACHING PREFERENCE (RQ3)**

#### **Key findings**

The present study found that male TFA accepted applicants were more likely to indicate a preference for teaching CS than female accepted applicants. Moreover, a greater proportion of accepted male TFA applicants preferred teaching CS, earned postsecondary CS credits, and majored in CS during postsecondary education than accepted female TFA applicants. These results are in alignment with previous studies that found that gender disparities in CS exposure and interest exist and persist throughout primary, secondary, and postsecondary education. Compared to males, females experience greater negative gender stereotypes (Dasgupta & Stout, 2014; Goode, Estrella, & Margolis, 2006); lower CS course enrollment (Code.org, CTSA, & ECEP Alliance, 2021); fewer female role models (Goode, 2008); lower awareness of CS opportunities (Wang & Moghadam, 2017); less encouragement from parents, teachers, and media to participate in CS courses; and lower confidence in learning CS (Google Inc. & Gallup Inc., 2016a). These factors could explain why there are differences in post-secondary CS credits, CS majors, and preference to teach CS among accepted female TFA applicants compared to accepted male TFA applicants. Our results provide additional evidence to support the idea that gender disparities in exposure to CS instruction exist and exacerbate the underrepresentation of females in CS careers and CS education.

#### **Considerations and examples**

*Consideration 2: Create inclusive CS learning environments throughout K-12 schools, preservice teacher programs, and alternative teacher development pathways that abate beliefs that CS is a male field.*

Schools and teacher preparation program leaders should recognize that gender stereotypes develop at an early age,

become reinforced within school classrooms (Gunderson et al., 2012), and negatively influence female students' interests in learning CS (Cheryan et al., 2009, 2011; Master, Estrella & Margolis, 2016). One solution to reduce prevalent gender stereotypes is to develop mentorship programs, communication approaches, and inclusive learning environments that increase female students' belonging, confidence, and interest in learning CS.

National efforts to broaden participation in computing through accessible course experiences have shown promising results for inclusive approaches that normalize computing education as welcoming for all students. Exploring Computer Science (ECS), an introductory course for high school students, has a record of attracting and retaining girls in learning foundational computing concepts within an inquiry-based learning environment (Goode & Margolis, 2011). The course is characterized by providing a "personally authentic learning" CS experience for students and has a legacy of gender parity through its focus on inclusive pedagogy and engaging course content. The ECS course, when adopted and sustained in school communities, establishes CS education as a learning space for all students, not just for boys or students with preparatory privilege in computing (Goode, Margolis, & Chapman, 2014).

Mentoring programs such as Computer Science for Rhode Island (CS4RI),<sup>6</sup> a state initiative that launched in 2016, focuses on increasing students' exposure to CS instruction in high school classrooms by matching CS professionals or "industry mentors" with students who are enrolled in a Work-Based Learning (WBL) project course. Throughout the WBL course, high school students can learn more about the CS field, gain hands-on experience, and have access to a role model. In addition, universities such as Purdue<sup>7</sup> and the University of California Irvine<sup>8</sup> offer mentorship programs that partner with high schools to promote female high school students' exposure to CS topics. Universities also have implemented mentorship initiatives to increase female undergraduate students' awareness of CS subjects, such as the Tufts University Women in Computer Science (WiCS)<sup>9</sup> and Simon Fraser University WiCS<sup>10</sup> mentorship programs. Exploratory results from this study, taken together with past studies, suggest that implementing a CS mentoring program targeting female students from K-12 schools would increase female students' access to CS role models and, in turn, increase their interest in CS-related careers such as CS teaching.

When parents, teachers, guidance counselors, academic advisors, and school leaders effectively create a safe and inclusive environment, it has the potential to encourage

girls and nonbinary students to join mentorship programs, CS clubs, CS extracurricular activities, CS internships, and CS summer programming. Communication strategies such as adopting toolkits to teach instructors about implicit bias in the classroom may reduce gender disparities. For example, toolkits such as CS4RI's BPC Toolkit<sup>11</sup> and the United Nation's Gender-Responsive Pedagogy Toolkit for Teachers and Schools<sup>12</sup> can help guide school leadership to ensure that they are creating an inclusive environment for all genders. Additional strategies that have shown to be effective in increasing female participation in CS courses include changing CS course names to sound less intimidating, creating another introduction-to-programming course targeting students without any prior programming experience, and forming a women's CS club (NPR, 2017). By creating gender-inclusive CS learning environments that seek to disrupt gender stereotypes, schools can potentially help increase the appeal of CS instruction to female and non-binary students and increase their interest in CS-related careers.

### RACIAL/ETHNIC DIFFERENCES IN POSTSECONDARY CS CREDITS, POSTSECONDARY CS MAJOR, AND CS TEACHING PREFERENCE (RQ4)

#### Key findings

Teach for America diverges from most other traditional pre-service teacher programs and has a national recruitment team that focuses on recruiting teachers, especially teachers of color, who have academic background in the fields adjacent to their prospective teaching profession. As a result, TFA has a higher proportion of accepted applicants from racially/ethnically minoritized groups than traditional preservice teacher preparation programs and the general in-service teacher workforce (McFarland et al., 2018; National Center for Education Statistics, 2022, 2023; Teach for America, 2023; The New Teacher Project, 2020; U.S. Department of Education, 2023). Past literature, taken together with the current study's findings, suggests that alternative teacher development pathways such as TFA are in a unique position to increase diversity in the CS teacher workforce (U.S. Department of Education, 2016, 2022). Programs such as TFA are positioned to leverage the relatively higher proportion of racially/ethnically minoritized teachers in their program to bolster and diversify the CS teacher workforce (The New Teacher Project, 2020).

#### Considerations and examples

*Consideration 3: Develop communications, initiatives, and recruitment materials that specifically engage prospective teachers from racially/ethnically minoritized groups.*

Program leaders and administrators from alternative teacher development programs should consider

developing recruitment materials to encourage prospective teachers from minoritized groups to teach CS. Programs with an evidence-based design—like Computing Principles for All Students' Success (ComPASS)—have been shown to successfully recruit undecided and non-STEM undergraduate students to choose a STEM field. Recruitment strategies such as implementing a marketing campaign to spread awareness of the ComPASS program have been effective in engaging students and parents of undecided and non-STEM students to participate in the program. In addition, both undecided and non-STEM students are assigned a STEM program advisor, matched with an experienced STEM peer mentor, given the chance to network with program peers and STEM graduate tutors, and provided opportunities to engage with early research experiences (Dagley et al., 2016). The University of Central Florida has adopted the ComPASS program model to help undecided students explore opportunities in STEM. Alternative teacher development programs that develop communications, initiatives, and recruitment materials similar to those of ComPASS can potentially bolster the number of prospective teachers of color.

Another program that addresses CS equity in the classroom is the Computer Science Teachers Association (CSTA) Equity Fellowship.<sup>13</sup> This one-year selective program receives applicants from in-service CS teachers as well as non-CS educators, educational leaders, administrators, and others who have demonstrated roles that support K-12 CS teachers. Admitted applicants receive a stipend, professional learning from well-known CS leaders, CS networking opportunities, and dedicated support from CSTA. Alternative teacher development programs may consider partnering with CSTA and similar organizations to incorporate an Equity Fellowship program to recruit prospective teachers of color into the CS teacher workforce.

The findings from the current correlational study suggest a promising path for future research that can establish a causal link between using communications, initiatives, and recruitment materials and attracting prospective teachers of color. Pending the findings of future research, program leaders and administrators also may also consider developing recruitment materials to encourage prospective teachers early in their teacher preparation pathway to learn about CS opportunities in order to spark their interest in teaching CS.

#### LIMITATIONS

The study is not without limitations. This is a correlational study and findings cannot be used to make causal inferences about the relationship between CS major

or CS credits and a preference to teach CS. Without an experimental design using random assignment of key independent variables, it is not possible to say that requiring CS course taking in teacher development or alternative certification programs would lead to preferences to teach CS. Readers should interpret the results with caution pending future research using experimental designs with random assignment.

In addition, this study drew from gender and race/ethnicity identity information using a structured questionnaire containing response options that may mask variation in how respondents identify their gender and race/ethnicity. For example, all Asian American and Pacific Islander racial/ethnic groups were grouped together. Furthermore, the gender demographic question only contained the response option “other” for those who did not identify with the gender binary. In some analyses, the number of accepted applicants in each racial/ethnic or gender identity group is less than 5, and thus, proportions should be interpreted with caution.

Finally, this study only examined TFA applicants who were ultimately accepted into the 2016 to 2020 corps; the present study’s analyses don’t include data from applicants who were not ultimately accepted into 2016–2020 corps. This study’s sample is different from traditional pre-service teachers at most university-based schools of education and so results may not be generalizable to all preservice teachers. Future studies could seek to use a probabilistic sample method to examine a representative sample of prospective teachers and improve external validity.

## CONCLUSION

By analyzing data pulled from accepted TFA applicants’ postsecondary transcripts and responses to an application questionnaire, the current study sought to understand factors related to interest in teaching CS among prospective teachers. Findings from this study show that earning at least one postsecondary CS credit and majoring in CS are positively associated with these prospective teachers’ preference to teach CS.

These findings indicate a rationale for further study of whether requiring preservice teachers in alternative certification programs to take a CS education course, seminar, professional development training, or workshop would increase prospective teachers’ interest in teaching CS. Future research could consider whether implementing activities and initiatives that target females and racially/ethnically marginalized peoples for recruitment into CS alternative certification pathways result in greater representation of these teachers in CS teaching positions.

If future research indicates a causal link between exposure to CS instruction and teachers’ preference for entering CS teaching positions, policymakers and practitioners would have a meaningful lever for reducing CS teacher shortages and diversifying the workforce.

In addition to using study designs appropriate for making causal inferences, future research could also examine a population of preservice teachers outside of TFA, collect data on TFA applicants’ employment outcomes, capture TFA applicants’ experiences teaching CS after they have become in-service teachers, and employ data collection methods (interviews, focus groups, and surveys) to capture insights into applicants’ experiences with CS in their post-secondary education including the CS content knowledge they acquired and their motivations to major in CS. This additional information would add to the field’s understanding of the teaching preferences of preservice teachers.

## DATA ACCESSIBILITY STATEMENT

TFA corps application data for those accepted to corps cohorts between 2016 to 2020 were used to write this publication. These data are not available for public inspection due to the risk of compromising participant anonymity and potentially sensitive cultural information. TFA agrees with its applicants to limit its sharing of applicant and participant data to contracted partners and only shares information reasonably needed for its partners to perform their functions.

## NOTES

- 1 For more information on aspects of the TFA corps program consult: <https://www.teachforamerica.org/experience/preparing-to-teach>.
- 2 The current TFA application can be found here: <https://www.teachforamerica.org/eligibility/>.
- 3 Descriptive analysis results broken down by each racial/ethnic identity can be found in within Appendix A.
- 4 <https://studentaid.gov/understand-aid/types/grants/pell>.
- 5 <https://uteach.utexas.edu/cs-pathway>.
- 6 <https://www.cs4ri.org/>.
- 7 <https://www.cs.purdue.edu/outreach/magic.html>.
- 8 <https://wics.ics.uci.edu/>.
- 9 <https://wicstufts.wixsite.com/wicstufts>.
- 10 <https://www.sfu.ca/computing/wics/>.
- 11 <https://www.cs4ri.org/educators-overview>.
- 12 <https://www.ungei.org/publication/gender-responsive-pedagogy-toolkit-teachers-and-schools>.
- 13 <https://www.csteachers.org/page/csta-equity-fellowship>.
- 14 More information on TFA’s data usage agreements can be found in their privacy policy: <https://www.teachforamerica.org/privacy-policy>.

## ADDITIONAL FILES

The additional files for this article can be found as follows:

- **Appendix A.** Analysis Tables. DOI: <https://doi.org/10.26716/jcsi.2024.02.01.44.s1>
- **Appendix B.** Sample Figures. DOI: <https://doi.org/10.26716/jcsi.2024.02.01.44.s2>
- **Appendix C.** Sample Tables. DOI: <https://doi.org/10.26716/jcsi.2024.02.01.44.s3>

## ETHICS AND CONSENT

The authors have no competing interests to declare. No financial interest or benefit has arisen from the direct applications of our research. AIR's Institutional Review Board (IRB00000436/FWA00003952) provided approval for the study activities described in this paper. TFA applicants gave permission to share their anonymized application data in pursuit of furthering TFA's mission, including for research and evaluation purposes.<sup>14</sup>

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## COMPETING INTERESTS

The authors have no competing interests to declare.

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