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Pinpointing Persistence in Alternative STEM Pipelines: Evidence from a Novel Coding and Apprenticeship Program

Wenrui Huang
Johns Hopkins University

Dajanae Palmer
University of Missouri, Columbia

Ekaete Udoh
University of Missouri, Columbia

Yung Chun
Washington University in St. Louis

Jason Jabbari
Washington University in St. Louis

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Wenrui Huang[1]
Dajanae Palmer[2]
Ekaete Udoh[2]
Yung Chun[3]
Jason Jabbari[3]

[1] Johns Hopkins University
[2] University of Missouri, Columbia
[3] Washington University in St. Louis

Abstract

The shortage of STEM workers, particularly in computer science, is compounded by the underrepresentation of women and certain minoritized racial/ethnic groups in these fields. Efforts to address worker shortages and broaden participation include improving traditional STEM education pathways and creating alternative pathways. While persistence has been examined in traditional STEM pathways, less is known about persistence in alternative STEM pathways. To bridge this gap, we conduct a mixed-methods analysis of persistence in LC101, a novel coding and apprenticeship program offered by LaunchCode that seeks to serve larger shares of women and certain minoritized racial and ethnic groups compared to traditional STEM education pathways. Leveraging novel survey data, generalized ordered logistic regression modeling, and in-depth interviews, we examine barriers and opportunities for increasing persistence in LC101. We find that test scores and prior coding experience were significantly associated with persistence across both the coursework and the apprenticeship phases of the LC101 program, while educational attainment was not significantly associated with persistence in either of these phases. Moreover, when accounting for all other factors, Black students are more likely to complete the apprenticeship component, suggesting that alternative STEM programs may represent vehicles for racial equity in STEM. Concerning support, we find that having mentorship after applying to LaunchCode increased the likelihood of course completion. By exploring students' motivations for applying to LaunchCode, we find that interest alignment is highest among course completers while higher pay, better benefits, and increased stability are highest among non-completers. We also found that time constraints and course difficulty were the two largest barriers to course completion. We conclude with implications for policy, programs, and practice.

Keywords: STEM Education Persistence; STEM Workforce Shortage; Alternative STEM Pathways; Mixed-Methods Analysis; Coding Apprenticeship

Introduction

Improving science, technology, engineering, and math (STEM) education has been a longstanding goal of U.S. educational policy since the launch of Sputnik in 1957. A strong STEM workforce is believed to benefit the nation's economic competitiveness and citizens' social well-being, as innovation from STEM workers creates more jobs for non-STEM workers than any other sector (National Research Council, 2011). According to the U.S. Bureau of Labor Statistics (2024), STEM occupations offer some of the highest wages in the U.S. economy with a median annual income of $104,420 in 2023 compared to $48,060 in non-STEM occupations. Given recent technological advances (e.g., in Artificial Intelligence), it is unsurprising that the number of STEM jobs is projected to grow at faster rates than the number of non-STEM jobs (U.S. Bureau of Labor Statistics, 2021). While these trends represent individual benefits of STEM employment, there are also communal benefits to STEM education. STEM education institutions often create new business ventures in their communities (Billing et al., 2023), and individuals who hold a STEM degree tend to have increased wages compared to other individuals in their respective communities (Winters, 2014).

Despite the rising number of STEM jobs, there is still a shortage of STEM workers; this shortage can be traced to a shortage/scarcity of STEM educational opportunities, particularly for computer science. Currently, there are 377,500 open computing jobs in America (U.S. Bureau of Labor Statistics, 2024), yet only 90,942 computer science graduates are entering the workforce (Code.Org, 2023). Moreover, our current system for providing educational opportunities to STEM workers is inefficient and inequitable. Less than 20% of computer science graduates are women and less than 10% are Black or Hispanic (Code.org, 2023). These current realities in computer science reflect larger trends in STEM, which demonstrate that women (Pantic & Clarke-Midura, 2019) and persons of color (e.g., Black and Hispanic individuals) (Pew Research Center, 2018) remain severely underrepresented in STEM education (Jabbari et al., n.d). Furthermore, when examining the overall shortage of STEM workers and the underrepresentation of women and persons of color, it is important to recognize that this disparity is not the result of a lack of interest in STEM, but rather stems from factors disproportionally affecting women and persons of color including initial exclusion and attrition in STEM education (Jabbari et al., 2023). As a result, a "leaky pipeline" metaphor has been used to describe STEM education (Almukhambetova et al., 2023).

In response to a growing demand for technological skills in the labor market coupled with continued patterns of exclusion and attrition in STEM across a continuum of education institutions, two major efforts have emerged in recent years. First, stakeholders have made efforts to "patch the leaks" in our current STEM education pipelines, which consists of a continuum of STEM education opportunities across both secondary (e.g., advanced STEM course-taking) and post-secondary (e.g., 2- and 4-year degree programs) traditional education institutions. Second, stakeholders have created alternative pipelines (e.g., certificate and apprenticeship programs) in non-traditional education institutions (Jabbari et al., 2023). One of the largest and fastest growing alternative STEM education pipelines involves learning computer science skills through short, intensive programs known as "Coding Bootcamps" (referred to as bootcamps hereafter). As noted by Jabbari et al. (2023), bootcamps often have fewer barriers to entry, shorter time commitments, lower tuitions, and more direct connections to employment (e.g., through internships). Thus, bootcamps can be seen as a pipeline that improves social mobility, gender, and racial/ethnic equity in STEM (Jabbari et al., 2022).

Nevertheless, while persistence has been examined in traditional STEM pipelines (Xie et al., 2015), less is known about persistence in alternative STEM pipelines. If we do not consider issues of persistence in alternative STEM preparation pipelines, then the programs within them run the risk of facing similar efficiency and equity problems that have previously plagued programs in traditional STEM preparation pipelines. To fill this gap, we conduct a mixed-methods analysis of persistence in programs offered by LaunchCode—one of the first and largest providers of alternative STEM preparation programs in computer science. LaunchCode is uniquely positioned to examine persistence as it directly impacts both efficiency and equity. Regarding efficiency, LaunchCode involves a paid apprenticeship program that directly connects graduates to STEM employment. In terms of equity, LaunchCode is free and seeks to serve a demographic that is representative of the surrounding urban community.

While few studies leveraged qualitative methods to explore students' experiences in bootcamps, these characteristics have yet to be examined quantitatively. Our previous studies have demonstrated that the efficiency (Jabbari et al., 2024) and equity (Jabbari et al., 2023) of these programs can differ across components relating to both coursework and applied work (i.e., apprenticeships). To examine the sociodemographic and educational characteristics related to persistence across both the coursework and apprenticeship phases of the LC101 program, we

leverage detailed survey data through generalized ordered logistic regression. We also consider how motivations for starting the program may be related to persistence across these phases. Additionally, given our focus on equity, we consider the personal and structural barriers and facilitators to persistence and how these differ across gender and race/ethnicity. To help explain these findings, we conducted semi-structured interviews with 22 students and 3 instructors. In our study, we now pose the following research questions:

1. What are the sociodemographic and educational characteristics related to persistence across both the coursework and apprenticeship phases of the LaunchCode program?
2. What are the barriers and facilitators to persistence and do these vary across gender and race/ethnicity?
3. How do students experience the LaunchCode program and how might these experiences explain overall trends in persistence?

This study provides an analytical lens for understanding persistence in a novel coding bootcamp and apprenticeship program. By considering the multifaceted factors influencing persistence, such as sociodemographic characteristics, educational and employment history, resources, and economic shocks, we provide a more comprehensive understanding of persistence in bootcamps. Examining student motivations helps clarify why some students persist while others do not, offering insights into student selection. Identifying specific barriers and facilitators to persistence across gender, race, and ethnicity can identify areas for intervention. Finally, understanding students' experiences provides a better understanding of the challenges they face when seeking alternative pathways to STEM employment. Overall, our study provides actionable insights for designing alternative STEM education programs that not only attract but also sustain a diverse and inclusive cohort of learners, ultimately creating a more efficient and equitable STEM pipeline.

Background

STEM Persistence

Persistence in STEM education can be conceptualized as progression through a series of learning opportunities. These opportunities can begin as early as elementary school and, traditionally, end in a college STEM major. One of the underlying premises of STEM persistence is that learning opportunities are often sequential and time-limited. For example, it is difficult to take calculus

without first taking algebra, which typically needs to be completed during students' first year of high school to take calculus by their senior year (Burkam & Lee, 2023).

Due to the stable transition from majoring in a STEM field in college to working in a STEM occupation in the labor market (i.e., the employment connection), the "pipeline" metaphor is used by both researchers and policymakers to demonstrate the pathway from STEM education to STEM employment. While some researchers have demonstrated that there can be multiple exit and entry points in the STEM pipeline (see Xie & Shauman, 2003), these demonstrations often involve core structures of the pipeline itself—formal systems of secondary (e.g., high school coursework opportunities in STEM) and postsecondary (e.g., 2- and 4-year degree programs in STEM) education.

As noted by Jabbari et al. (2023), persistence in STEM education requires general education persistence. For example, a student cannot major in a STEM field without first being accepted, attending, and graduating from college. Additionally, persistence in STEM education requires that learning opportunities are available and selected by students. The availability of STEM learning opportunities is dependent on the student's previous experiences and success within these opportunities. Students decide—based on interest (Maltese & Tai, 2011) and other factors—whether to partake in these opportunities, determining their persistence in STEM education. By persisting, students can be seen as "specializing" in STEM. As such, instances of non-persistence, or "leaks," in the STEM pipeline can occur both vertically (related to general education progression) and horizontally (related to STEM education specialization). Vertically, students can "slip through the cracks" by not progressing in formal education (e.g., not completing high school, not attending college, or attending but not completing college). Horizontally, within a given level of educational attainment, students specialize in STEM (e.g., by enrolling in an advanced STEM course, joining a specialized STEM club, etc.).

To understand the factors associated with vertical and horizontal persistence in STEM, Xie and colleagues' 2015 review offers valuable insights. The authors demonstrate that education attainment often considers (a) individual factors that can consist of cognitive and noncognitive skills, (b) family factors, that consist of parents' experiences and expectations, and (c) contextual factors, that consist of neighborhood and school quality. These factors can also influence STEM education attainment.

Most relevant to our study are the contextual factors related to schools, particularly regarding STEM education opportunities. For example, advanced STEM courses are not offered in all high schools (Iatarola et al., 2011). In college, students must often pass prerequisite courses—sometimes referred to as "gatekeeper" courses—before advancing to higher-level STEM classes (Bryk & Treisman, 2010; Wang, 2016). The link between high school and college educational opportunities is one of the strongest predictors of persistence in STEM fields. Multiple studies demonstrate the importance of taking STEM courses in high school, which predicts enrollment in college STEM courses and ultimately impacts majoring and employment in a STEM field (Gottfried, 2015; Sadler & Sonnert, 2018; Tyson, 2011). However, without continuing to college, high school STEM course-taking alone has minimal influence on securing STEM-related employment (Bozick et al., 2017).

Given these factors, it is not surprising that only about 28% of bachelor's and 20% of associate's degree students entered a STEM field during the 6 years of the Beginning Postsecondary Students Longitudinal Study (2003-2009) (Chen, 2013). By the end of the 6 years, 48% of bachelor's degree students and 69% of associate's degree students left these fields (Chen, 2013). Roughly half left college altogether ("vertical" non-persistence), while the other half pursued another major ("horizontal" non-persistence). While some individuals switch to STEM after declaring another major, unlike other fields, the number of students that switch to STEM pales in comparison to the number of students that switch out—by some estimates the proportion of incoming to outgoing students is 1:12 (Olson & Riordan, 2012).

Differences in gender and race/ethnicity have also been related to general educational attainment, as well as STEM specialization. Male students, as well as Black and Hispanic students, often experience unique environmental stressors that can limit their progress, such as school punishment (Jabbari et al., 2024) and neighborhood violence (Harding, 2010). Given these trends, it is unsurprising that male students are far less likely than female students to graduate high school and enter college (Reeves-Allen, 2023). Conversely, female, Black, and Hispanic students often experience unique social challenges, such as stereotype threats (Spencer et al., 1999; Steele & Aronson, 1995) and other forms of discrimination (McGee, 2016, 2020; Robinson et al., 2016), that limit their specialization in STEM. From these trends, it is unsurprising that Black students are twice as likely to switch out of a STEM major as White students (Olson & Riordan, 2012).

Coding Bootcamps

While general education progression is a prerequisite in traditional STEM education pipelines, it is not a prerequisite in alternative STEM education pipelines. As a result, alternative STEM education pipelines may represent a more efficient and equitable pipeline to STEM employment. While there are various alternative STEM preparation programs, we focus on those specializing in computer science. Bootcamps are unique in that they prepare students for entry-level computer science jobs that are often similar to those pursued by bachelor's degree holders. As described by the World Bank (2017), most bootcamps embody three main components:

1. Intensive rapid skills training with a competitive selection process, typically lasting no more than six months.
2. Teaching methods that follow a project-based, experiential learning approach.
3. Curricula that reflect current industry needs, with teaching subjects adapted according to local demand.

Given the abbreviated time frame, bootcamps focus on the more applicable aspects of computer science, as opposed to the more theoretical aspects. In doing so, bootcamps allow students to focus on the most important and in-demand coding skills for success in an entry-level computer science position (Waguespack et al., 2018, p. 49). To ensure that these skills are offered, bootcamps often consider national job trends and work closely with local employers.

Bootcamps attempt to offer low opportunity costs and high labor market rewards. For example, recent survey data with over 3,000 bootcamp graduates from over 100 bootcamps conducted by Course Report, a bootcamp industry monitor, found that the average length for in-person bootcamps was 14.4 weeks with an average tuition of $14,214 (Eggleston, 2018). Moreover, 79% of graduates were employed after completing a bootcamp and the average student experienced a 57% increase in earnings (Eggleston, 2020). However, as noted by Jabbari et al. (n.d.), these survey results lack a comparison group, which makes it difficult to ascertain potential selection effects. For example, although bachelor's degrees are not required for bootcamps, 74% of survey respondents had earned a bachelor's degree before starting a bootcamp in 2020 (Eggleston, 2020).

In terms of efficiency, approximately 58,756 students graduated from bootcamps in 2023 (Career Karma, 2023; Course Report, 2023). This is quite substantial given that only 93,000 students graduated from computer science degree programs (Career Karma, 2023). In terms of

equity, women comprised 40% of recent code camp graduates compared to just 17% of recent computer science graduates. Given these trends, studies have begun examining the experiences of women in bootcamps. Using qualitative interviews with 18 students, Seibel and Veilleux (2019) found that many women were initially deterred from majoring in computer science in college due to a lack of knowledge about the subject, lower levels of self-efficacy in related math skills, and college courses with fewer women. These women later entered bootcamps after gaining more knowledge of computer science, having positive experiences in coding, and receiving support from family and friends (Seibel & Veilleux, 2019). Lyon and Green (2020) expanded these findings through qualitative interviews with 36 students, which found bootcamps helped women change careers and achieve career success. Despite the noted gains in gender diversity, gains in racial and ethnic diversity have not been widely observed in coding bootcamps: Black individuals comprised just 7% of recent cohorts of bootcamp graduates, which is an improvement from previous years but is still lower than the 9% representation in computer science bachelor's degree programs (Course Report, 2023; Career Karma, 2023).

As suggested by the findings of Jabbari et al. (2023), the relatively small proportion of Black individuals graduating from bootcamps is both a product of exclusion and attrition. While community outreach and holistic admissions policies can create more racially and ethnically diverse bootcamp cohorts, more must be done to ensure persistence—particularly in program components related to employment connections. For example, in a study of 4,868 applicants to LaunchCode's earlier cohorts, Jabbari et al. (2023) found that community outreach and holistic admissions policies increased the number of Black individuals completing the coursework phase but not the apprenticeship phase. These effects were largely due to changes in admission rather than changes in completion.

In the same study by Jabbari et al (2023), they also found that it is still possible that the underlying substance of these courses could affect persistence even if prerequisite courses are not required for entrance into bootcamps. For example, through a qualitative study of 26 students at 6 bootcamps, Thayer and Ko (2017) demonstrate that participants without a background in technology often experienced more difficulties than those with a background in technology. Nevertheless, there may be particular aspects of bootcamps that can help increase persistence—even for students without a background in technology. For example, Lyon and Green (2021)

demonstrated that mentors helped build confidence and increase persistence for many bootcamp students.

Study Setting

LaunchCode, a 501(c)(3) non-profit organization, was founded in 2013 with a mission "to help people with nontraditional backgrounds find fulfilling, upwardly mobile careers, and to help companies find skilled, new tech talent from all backgrounds and walks of life." LC101, LaunchCode's flagship program, is a part-time, evening program that includes two core components: (1) a free 20-week coding course and (2) a paid apprenticeship at a local employer that can last 12-52 weeks. Between these core components is a "lift-off" phase in which students develop a portfolio project to demonstrate their skills to employers and prepare for interviews. The apprenticeship program not only helps facilitate a more efficient transition to the labor market for LaunchCode graduates, but also helps subsidize the cost of the program. A portion of the apprenticeship pay is used to fund LaunchCode's operations, making it free for all students. LC101's courses consist of two units: (1) a JavaScript unit where students learn foundational programming concepts and (2) a Java or C# unit where students learn to build web applications. LaunchCode has historically required that admitted students (1) express an interest in having a career that involves coding; (2) have enough time to attend the courses and complete the assignments, which is estimated to be 15 hours/week; and (3) demonstrate proficiency on the HackerRank test, which assesses both critical thinking and problem-solving skills related to computer science.

Methods

Study Design

We use an explanatory sequential mixed-methods design, combining quantitative and qualitative approaches to develop a more comprehensive understanding of social phenomena (Aurther et al. (n.d.); Creswell & Clark, 2017; Ivaniski et al., 2022; Padgett, 2016). We begin with quantitative data collection, analysis, and interpretation, which then informs the qualitative phase. These findings are then compared to identify points of convergence and divergence (Ivankova et al., 2006). In this study, our quantitative methods first examine sociodemographic and educational characteristics related to persistence across LaunchCode's coursework and apprenticeship

phases. We then examine program motivation, personal and structural barriers, and facilitators to persistence. Finally, we leverage qualitative methods to further unpack these trends, detailing the lived experiences of both persisting and non-persisting program participants.

Quantitative Data

Our research draws from survey and administrative data on nine LaunchCode LC101 cohorts in St. Louis, Missouri the U.S. from January 2017 to May 2020. Survey data was collected in Summer 2021. 6,154 applicants were invited to complete the survey and were offered a $10 Amazon gift card incentive. The survey had a 21.4% response rate and a 91% completion rate. The median survey completion time was 18 minutes. After post-hoc data quality checks, responses from 1,006 participants were retained. As we focus on program persistence, our analytic sample focused on those who were admitted and started the LC101 course. The final analytic sample consisted of 524 individuals: 35.9% of our sample started but did not complete the course, 46.9% of our sample completed the course but not the apprenticeship, and 17.2% completed the apprenticeship. Participants' progression was categorized into three stages to provide a trajectory of their program persistence: "Non-completers", "Course Completers", and "Apprenticeship Completers".

In addition to program persistence, survey data captured sociodemographic and educational characteristics, program motivations, and an array of barriers and facilitators to persistence. Sociodemographic and educational characteristics consisted of age, gender, race/ethnicity, pre-LaunchCode income quartile, pre-LaunchCode employment, pre-LaunchCode educational attainment, previous coding experiences, outside mentorship, home ownership, transportation, and pandemic-related economic shocks (i.e., whether someone lost a job or income due to the pandemic). Motivations for pursuing LaunchCode were captured in the survey through Likert scales that ranged from "Not important at all" at the lowest level, "Slightly Important", "Moderately Important", "Very Important," and "Extremely Important" at the highest level. Reasons for non-persistence were also captured for students (246 non-completers) who did not move to the next phase. Here, it is important to note that students could "select all that apply"; as a result, reasons for non-persistence were not mutually exclusive. Administrative data captured HackerRank test scores, which measure critical thinking and problem-solving abilities related to coding.

Quantitative Analysis

It might seem reasonable to view persistence as a binary function. However, LaunchCode's program has multiple pieces within its pipeline to STEM employment that require a more nuanced approach. Given the sequential order of LaunchCode's coursework and apprenticeship components, an ordered logistic regression approach can be considered. Nevertheless, ordered logistic regression models have a proportional odds assumption, in which the odds of passing through each sequential piece are assumed proportional. After conducting a Brant test, we found that our data violated this assumption. As a result, we employed a *generalized* ordered logistic regression model that relaxes the proportional odds assumption using gologit2 (Williams, 2016). In addition to allowing for more accurate results, a generalized model allows us to go beyond understanding "what" predicts program attrition and persistence, which also allows us to understand "when" program attrition and persistence occur. Specifically, our model predicts the probability of advancing to the next "step" of LaunchCode's program and can be expressed as follows:

$$P(\text{Step}_i > f) = \frac{\exp(\alpha_j + X1_i\beta1 + X2_i\beta2_j)}{1 + \exp(\alpha_j + X1_i\beta1 + X2_i\beta2_j)} + \epsilon_j, \quad j = 1, 2, 3$$

Where…

- $P(Step_i > j)$ is the cumulative probability of moving to Step i
- j = 1, 2, 3, which represents the status category from started the course but did not complete the course (j = 1) to have completed the apprenticeship (j = 3).
- $X1_i$ indicates the set of variables in Table 2 describing step i that do not violate the proportional odds assumption, and βi represents the associated coefficients.
- $X2_i$ is a set of variables in Table 2 describing step i that violate the proportional odds assumption, and $\beta 2_j$ represents the associated regression coefficients.
- ε_j is the regression error term.

Additionally, ANOVA tests were used to examine how participants' motivations for applying LaunchCode related to program persistence. Finally, descriptive analyses were performed to explore the reasons for non-persistence in both the coursework and apprenticeship phases, with differences examined across gender and race/ethnicity.

Qualitative Data

The data informing the qualitative portion of this study come from 8 semi-structured interviews with LaunchCode instructors and 22 semi-structured interviews with LaunchCode students who were enrolled in a LaunchCode program between 2020 and 2021 (see Table 1). The participants were recruited via email from a list of participants provided to the research team by the LaunchCode staff. The research team attempted to have a diverse group of participants across race/ethnicity, gender, and socioeconomic status. Each interview lasted approximately 30-60 minutes. The interviews were conducted on Zoom, and participants were awarded a $40 gift card for their participation in the study. These data come from a larger project examining students' experiences in the LaunchCode program (Jabbari et al., n.d.).

Table 1. Interview Participants

Name	LaunchCode Program	Completion Status	Sex	Race/Ethnicity
John	LC101	Apprenticed	Male	White
Michael	LC101	Apprenticed	Male	Hispanic
Jillian	LC101	Apprenticed	Female	White
Christine	LC101	Apprenticed	Female	White
Michelle	LC101	Course completed	Female	Asian
Angela	LC101	Did not finish the course	Female	Black
Craig	LC101	Did not finish the course	Male	White
Amanda	LC101 Instructor		Female	

Qualitative Analysis

Similar to Jabbari et al. (n.d.), the analysis for the qualitative portion of the study was done using the Delve online coding platform for collaborative projects. Transcripts were uploaded to the Delve platform after being professionally transcribed. The research team utilized an iterative process to sort and order data into units of meanings, categories, patterns, and themes (Creswell, 2009). The first step of data analysis involved open coding to identify themes within data sources and develop categories. The second step of data analysis involved axial coding to generate subcategories, which allowed the research team to form more precise and complete explanations. The final stage involved selective coding (Strauss & Corbin, 1990) to systematically relate and refine categories and subcategories into theoretical constructions. Data triangulation was

achieved by comparing instructor and student interviews. The qualitative research team met after each round of coding to discuss processes, build consensus, and make meaning.

Given the quantitative findings, we focus our analyses on the educational characteristics, motivations, barriers and facilitators associated with persistence across the coursework and apprenticeship phases of the program.

Findings

Quantitative Findings

Descriptive Results

Table 2 presents descriptive results for our total 52 participants. The majority of our participants are between the ages of 19-34 (51.5%), identify as female or non-binary (53.2%), and are White (60.3%). Regarding family status, 46.0% are unmarried without kids, and 24.0% are married with children. Income quartiles range from 0-$20,000 (1st), $20100-$34,000 (2nd), $35,000-$47,000 (3rd), and $48,000-$113,424 (4th). Prior to LaunchCode, most participants (61.6%) were employed full-time, and less than half of participants (41.6%) held a bachelor's degree. A plurality had 1-50 hours of previous coding experience (44.7%), and most participants did not receive mentorship outside of LaunchCode (69.3%). Additionally, most participants did not report job or income loss due to COVID-19 (71.8.%), did not own a home (65.5%), and almost all participants had reliable transportation (98.7%).

Generalized Ordered Logistic Regression Results

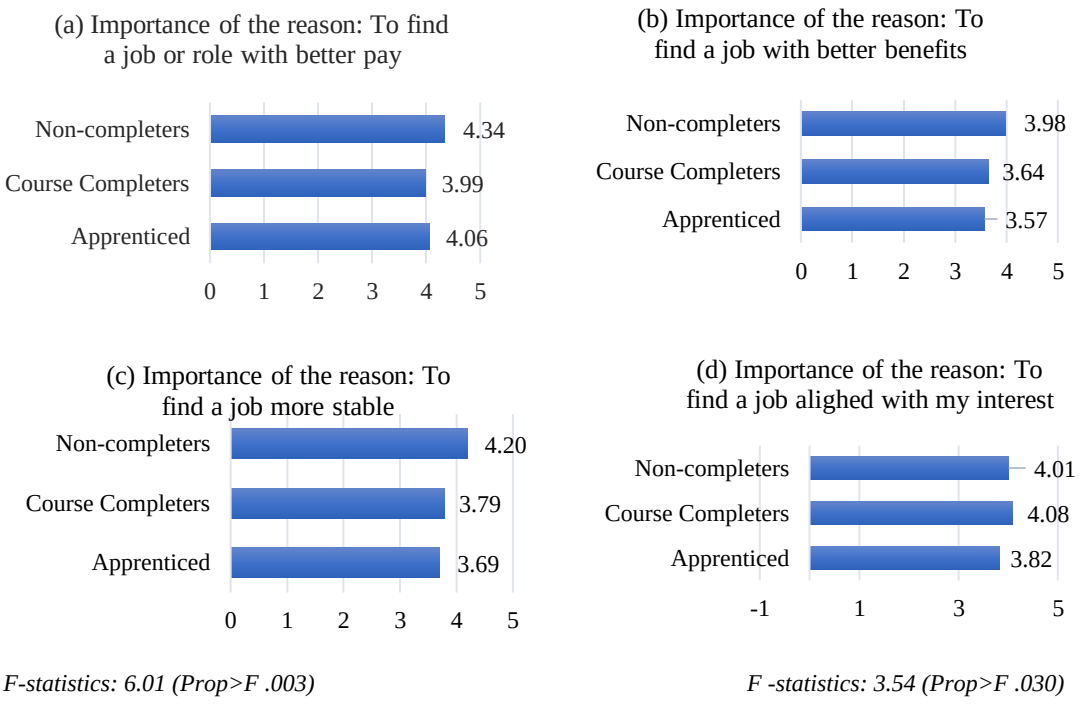
Hacker rank scores (OR=1.017**) and having 1-50 (OR=1.637*) and 51-250 (OR=1.967*) hours of previous coding experience were consistently associated with increased odds of persistence across both the coursework and apprenticeship phases while receiving mentorship outside of LaunchCode before applying to the program (OR=0.424**) was consistently associated with decreased odds of persistence across both phases. While having 251 or more hours of previous coding experience (OR=2.481*) was significantly associated with increased odds of persistence across the coursework phase, this was not significantly associated with increased odds of persistence across the apprenticeship phase. Moreover, while receiving mentorship outside of LaunchCode after applying to the program was significantly associated with increased odds of persistence in the coursework phase (OR=2.559**), the inverse

relationship was observed in the apprenticeship phase (OR=0.470*). Additionally, being between the ages 45-69 (OR=3.655**), being Black (OR=2.751*), and losing a job or income due to COVID-19 (OR=2.708**) were significantly associated with increased odds of persistence across the apprenticeship phase, while being married without kids (OR=0.419**) was significantly associated with decreased odds of persistence across the apprenticeship phase.

Motivations for Applying LaunchCode

Figure 1 shows the results of ANOVA tests that examine how different motivations for applying to the LaunchCode program vary across levels of persistence. While we presented statistically significant (i.e., F-statistics) results, we also examined additional motivations such as improved working hours and job enjoyment. However, the differences were not significant. First, we consider the importance of finding a job with better pay, which was highest among non-completers (4.34), followed by course completers (3.99) and apprenticeship completers (4.06). Second, we consider the importance of finding a job with better benefits, which was, again, highest among non-completers (3.98), followed by course completers (3.64) and apprenticeship completers (3.57). Third, we consider the importance of finding a job with more stability, which was highest among non-completers (4.20), followed by course completers (3.79) and apprenticeship completers (3.69). Finally, we consider the importance of finding a job that better aligns with personal interests, which was rated highest among course completers (4.08), followed by non-completers (4.01) and apprenticeship completers (3.82).

Figure 1. Perceived importance of the reasons that show significant differences among the three groups



F-statistics: 6.01 (Prop>F .003)

F -statistics: 3.54 (Prop>F .030)

Note: 524 participants in total; the x-axis represents the perceived importance scores for each reason.

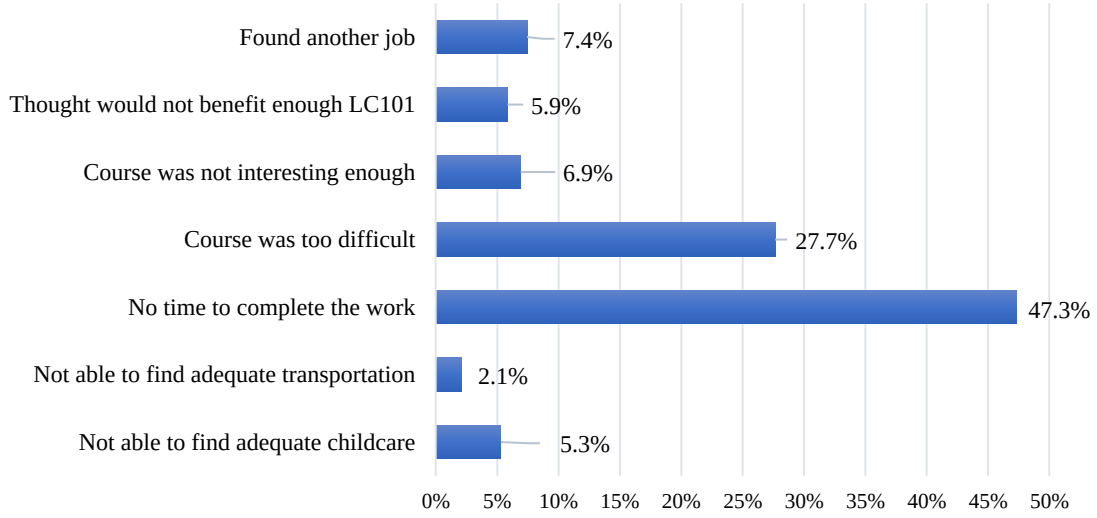
Reasons for Non-persistence in the Coursework Phase

Figure 2 illustrates the primary reasons participants did not complete the LaunchCode coursework phase. Time constraints were identified as the most significant barrier to persistence, with 47.3% of 524 participants citing it as a reason for non-completion, followed by course difficulty, which was cited by 27.7% of participants. Other notable factors affecting completion rates included finding another job (7.4%), a lack of interest (6.9%), and perceiving a lack of benefits (5.9%). Logistical issues like transportation and childcare were less commonly reported (2.1% and 5.3%, respectively).

Figures 3 and 4 display the reasons for not completing the course by gender and race/ethnicity. More female and non-binary participants than males cited lack of time, course difficulty, finding another job, lack of childcare, and insufficient perceived benefits as reasons for not completing the course. Concerning race and ethnicity, results were compared across demographic groups that have been historically overrepresented in STEM (e.g., White and Asian) to those historically underrepresented in STEM (e.g., Black and Hispanic). While more Black and Hispanic participants than White and Asian participants reported issues with

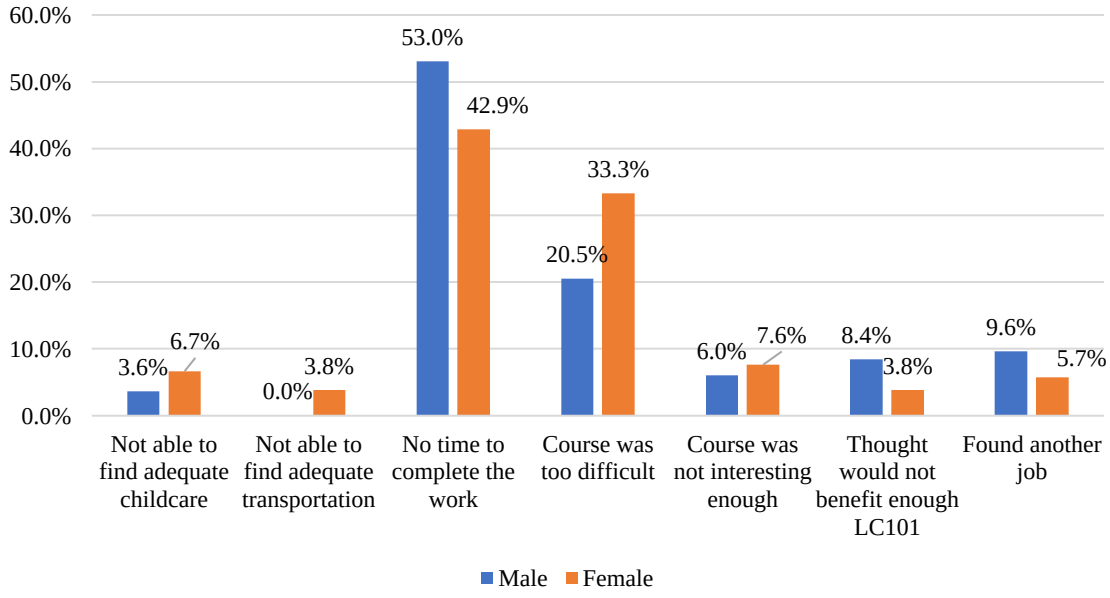
insufficient time (54.8% compared to 42.6%) and lack of adequate childcare (8.2% compared to 3.5%), more White and Asian participants reported issues with sufficient perceived benefits (8.7% compared to 1.4%).

Figure 2. Reasons for Not Completing LC101



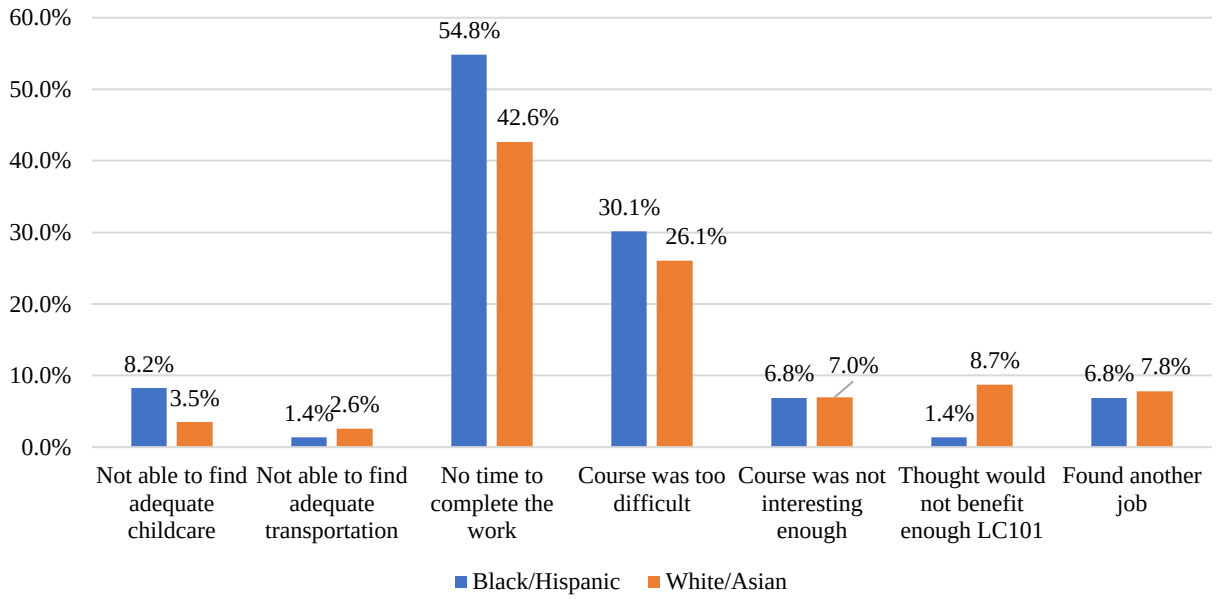
Note: 524 participants in total; the x-axis represents the percentage of participants

Figure 3. Reasons for Not Completing LC101 by Gender



Note: Out of 524 total participants, valid responses were received from 83 males and 105 females.

Figure 4. Reasons for Not Completing LC101 by Race



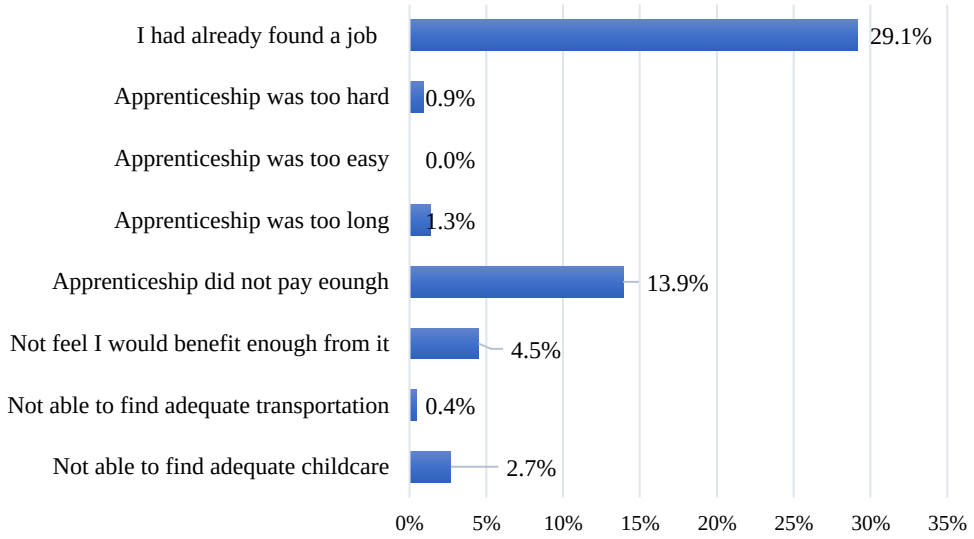
Note: Out of 524 total participants, valid responses were received from 75 Black/Hispanic and 115 White/Asian.

Reasons for Non-persistence in the Apprenticeship Phase

Figure 5 illustrates the primary reasons participants did not complete the LaunchCode apprenticeship phase. The most significant barrier to persistence was finding another job with 29.1% of participants citing it as a reason for non-completion. Low pay was also a notable barrier to persistence with 13.9% of participants.

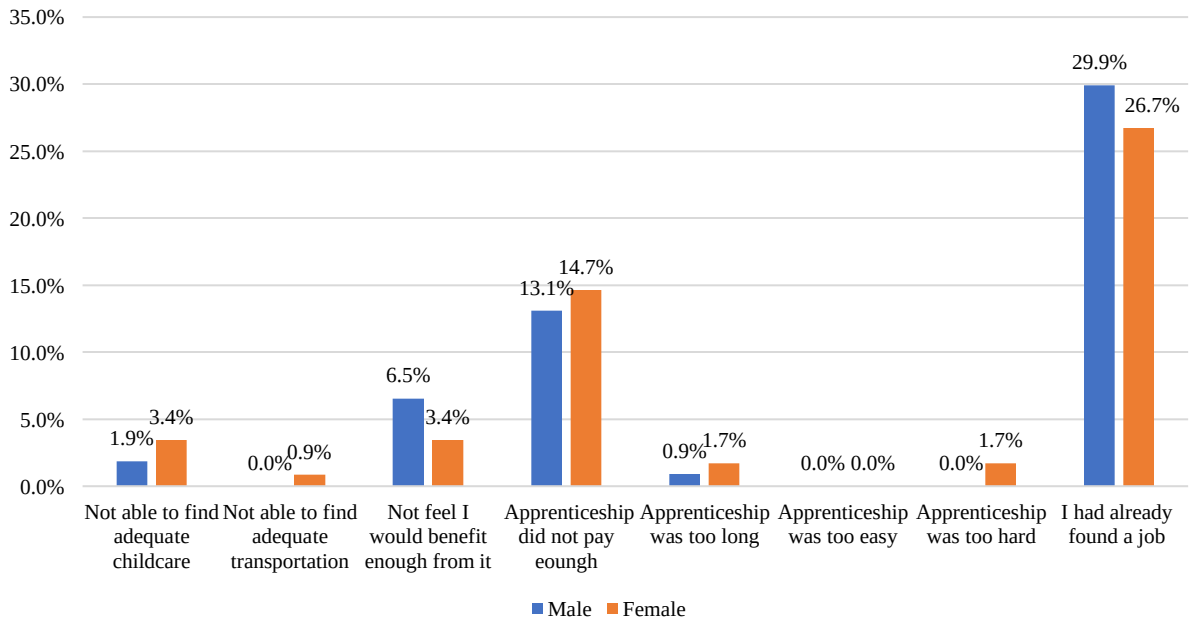
Figures 6 and 7 break down the reasons for not completing the apprenticeship by gender and race/ethnicity. A larger percentage of male participants compared to female and non-binary participants cited finding another job (29.9% compared to 26.7%) and not perceiving sufficient benefits (6.5% compared to 3.4%) as reasons for non-completion. More Black and Hispanic participants than White and Asian participants reported a lack of adequate childcare (5% compared to 1.8%). Finally, while "other" is not shown, differences were observed across gender and race/ethnicity. Specifically, the "other" responses were 2.8% for males and higher at 11.2% for females. In terms of race, 5.0% of Black respondents and 8.0% of White and Asian respondents selected "other".

Figure 5. *Reason for not Completing Apprenticeship*



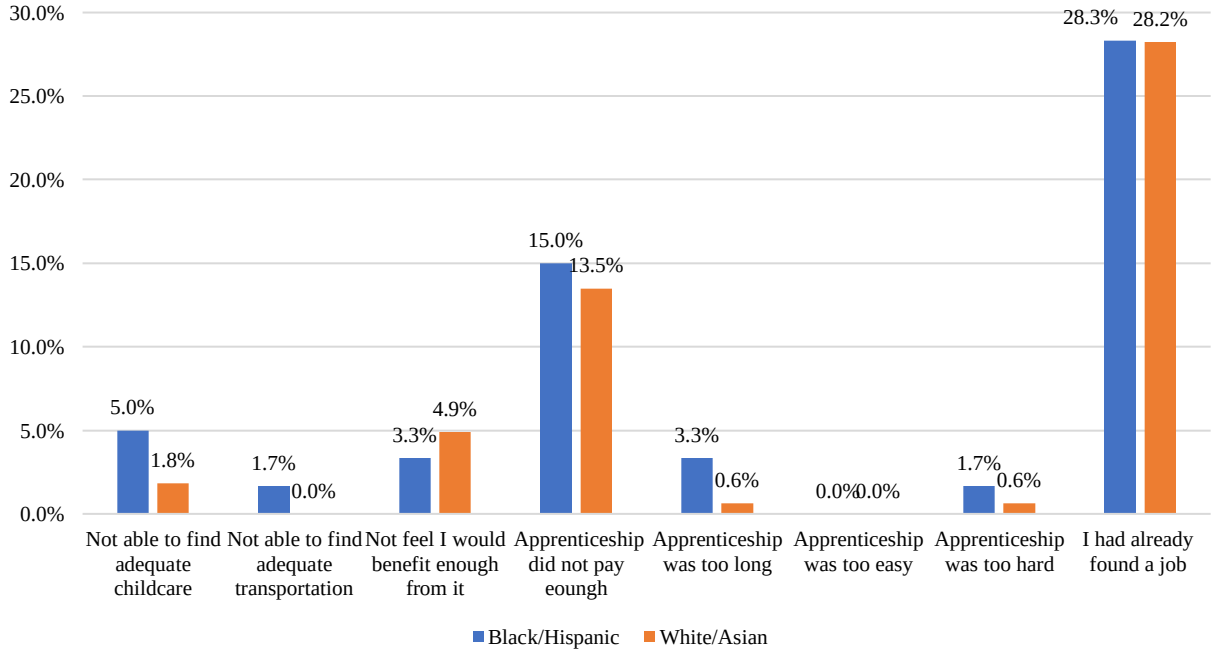
Note: 524 participants in total; the x-axis represents the percentage of participants

Figure 6. *Reasons for Non-persistence in Apprenticeship by Gender*



Note: Out of 524 total participants, valid responses were received from 107 males and 116 females.

Figure 7. Reasons for Non-persistence in Apprenticeship by Race



Note: Out of 524 total participants, valid responses were received from 60 Black/Hispanic and 163 White/Asian.

Qualitative Findings

Coding Interests and Experiences

Coding experiences emerged as a major theme related to persistence in the LaunchCode program. For example, Jillian, a White woman who completed the program's coursework and apprenticeship phases, described her interests and experiences in coding:

> "I was always interested in learning STEM skills like coding and web design and things like that. And so, I had taken a few classes in high school that kind of got me--piqued my interest a little bit. And then I wanted to kind of continue that education, but I was pretty indecisive in college choosing a major. And I chose business because it was pretty flexible and kept my options open. And I wasn't fully sure that I wanted to pursue a degree in STEM at the time, but I kind of wanted to take additional classes and things. And I had considered adding on a major or a minor or something like that, but I had too many interests and I was too indecisive. So LaunchCode was a good side-option, boot-camp-type—I don't know. It would focus on specific things, but I didn't have to make it my entire educational experience, I guess."

Jillian described practical experiences that influenced her decision to pursue and complete LaunchCode, such as enrolling in computer science courses in high school. Although she initially hesitated to commit to computer science in college, she described how LaunchCode provided her with the opportunity to engage in the field later. In addition to aligning with Jillian's interest, LaunchCode represented an educational pathway with fewer opportunity costs.

At the same time, the same qualities that help students persist in LaunchCode, such as interest and experience, can also open up STEM employment opportunities before they formally complete the program. For instance, Michelle, an Asian woman, described participating in LaunchCode's hack-a-thon in 2014 six years before finishing the program. Although she completed the course component, she did not participate in the apprenticeship because she independently found STEM employment immediately after completing the course. Thus, non-persistence can also include 'opt-outs' because of an abundance of early success rather than a lack of success in coding.

Time Constraints and Opportunities

Time was a recurring theme in the interviews; in addition to participants citing limited time to dedicate to the program, some, like John, noted that the disruptions caused by the COVID-19 pandemic created new opportunities.

> "I was like, 'Well, I don't know what else to do. I'll just finish my degree and go to teach English over there.' Yeah. And then because the pandemic happened, that kind of changed my trajectory completely because I didn't seem like that was going to happen anymore. And then eventually, yeah, I made my way to St. Louis and thought, 'I'll give LaunchCode a try.'" John (LC101, completer)

LaunchCode offered John a new career path after his plans for teaching English overseas were disrupted by the COVID-19 pandemic. In doing so, the pandemic can offer some people the time to find new professional directions. While John lacked some of the longstanding interests and experiences exhibited by Jillian, he had additional time resources that helped facilitate his persistence throughout the coursework and apprenticeship phases of the program. For example, some students were able to fully focus on the LaunchCode program by moving in with their parents and not having to work full-time. In doing so, he was able to focus his full attention on the LaunchCode program. Additionally, John was able to create a study group with other

LaunchCode students who also did not have to work during the program: “We had a little study group with some of my other unemployed friends who would meet once or twice a week, and I was able to really focus on it and devote a lot of time on it, and I think that helped a lot in my success.” He mentioned that he intentionally formed this group because other classmates had to work a full-time job or manage other responsibilities, like raising children, on top of attending the LaunchCode courses and completing the assignments.

Conversely, Craig's experiences demonstrate some of the challenges of finding enough time to dedicate to the program.

> “Yeah. And again, I think if I would have been—the full-time job. And again, there was overtime. But between that and LaunchCode, I think I could have done it. But between the full-time job plus going to school part-time, which was online, and also, I was a hybrid student. I went to [university], so I'd go to class sometimes on campus and other times online. The three of those things, LaunchCode, part-time college, and the job, that was too much. I kind of ended up biting off more than I could chew.”

Ultimately, Craig determined that he was involved in multiple other obligations and chose to withdraw from LaunchCode during the coursework phase. Like Craig, some students are working full-time and enrolled in other formal education programs. For them, LaunchCode may serve as a supplemental education program instead of an alternative education program. It is also worth noting that Craig’s other education program required tuition. While he didn’t explicitly say this influenced his decision, the free tuition in LaunchCode might lead students to drop out more easily, especially when faced with competing priorities, such as tuition-based education or paid employment.

Course Difficulty

Multiple participants, including non-completers and course and apprenticeship completers, expressed difficulty in keeping up with the LaunchCode curriculum. For example, Angela, who did not complete the course, expressed that it was not only fast-paced and difficult to keep up with, but also that she had limited time due to other obligations that prevented her from reviewing and comprehending the material afterward.

> “I felt that the LC101 course, it did kind of go—it kind of flew by. A lot of times we would be working on things. And I don't know. I'm a person who sometimes has to go

> and get extra help or needs to pull people to the side. Like, 'Can you discuss it further?' And I kind of just felt like—I don't know if the focus was more so on just getting the information out. And I don't know if necessarily the focus was to like you need to get every concept we do, but it's like you kind of need to understand each concept because it kind of builds on each other, so. But kind of just things just continue to just move, move, move without really being able to digest and understand and comprehend everything that was going on…I don't know if I just felt kind of overwhelmed or kind of feeling like I was off an island. I'm on my own, not feeling like I had—that I did the work, I guess, to have those people to reach out to for help. So yeah. I kind of just—I think I just got discouraged and overwhelmed by whatever the assignment was and just was like, 'I don't think this is for me.'"

When asked if anyone from LaunchCode reached out to her before she dropped LC101, she stated, "I don't think it was like, 'Hey, just want to reach out, make sure everything's–' it wasn't in that capacity." This reflects a lack of formal procedures to support students who found the course challenging or had limited time. At that time, there were no established processes in place to assist students who were struggling or falling behind.

Financial Constraints and Opportunities

Finally, some students, like Michelle, noted that apprenticeship pay was lower than permanent full-time roles, causing these students to seek employment opportunities outside of the apprenticeship component.

> "So, for the same skills that you have, wherever you go, it's like there are other people who see the value and will pay more. Whereas some of the partnerships with the people here that LaunchCode has, they pay, I don't want to say—well, I don't want to say below market, and I had interviewed with a company here. Actually, I tried a couple of companies and one of them—let's just say the IT help desk supervisor would make the same as someone who was above a level one software engineer at a large company."

Comparatively, lower apprenticeship pay is common across industries. However, because LaunchCode's free program is funded by apprenticeship subsidies (i.e., employers pay both the apprentice and LaunchCode during the apprenticeship period), this can create a situation in which a large number of students gain employment outside of the apprenticeship component,

limiting LaunchCode's ability to serve more students. Given Michelle's previous interests and experiences, she was able to interview and obtain a permanent, full-time employment role outside of LaunchCode's apprenticeship component. However, these tradeoffs may differ across students, as some students may prefer an apprenticeship role with lower pay to apply their newly acquired skills in a lower-stakes environment. In addition, some students may not be able to leave their current role for a lower-paying apprenticeship role due to certain financial constraints.

Finally, while the successful completion of the apprenticeship often involves conversion to a full-time role, it's important to note that even when conversion does not happen, students may still find permanent, full-time employment roles at other firms:

> "One of the guys I had taken the class with, he did an apprenticeship, did not get hired on where he was because they decided that it wasn't a good fit or for whatever reason. Got a job the next week making 80K. And it was 15K more than the people that did get brought on. So, I think it would be good to—and I think LaunchCode did try this, but it didn't work out at least the first time they tried to continue that mentorship through the first year or the first job for LaunchCode students, right? Again, it's hard, though. It's hard to find people who are wanting to volunteer." Amanda (LC101 Instructor)

While Amanda's description discusses how students can gain employment independently throughout the apprenticeship—even when things don't go well for an apprentice—it also notes LaunchCode's limited capacity to provide mentoring throughout the entire process, which can be helpful in these situations.

Discussion and Conclusion

Our study has examined persistence in alternative STEM pipelines, which has been underexamined/under-described/etc, compared to persistence in traditional STEM pipelines (Xie et al., 2015). By pinpointing persistence in alternative STEM pipelines, stakeholders can gain critical insights that can be used to avoid efficiency and equity problems that have plagued traditional STEM pipelines. To fill this gap, we conducted a mixed-methods analysis of persistence in programs offered by LaunchCode, an alternative STEM preparation program in computer science that has unique implications for both efficiency through its apprenticeship component and equity through its focus on serving women and persons of color. Specifically, we leveraged detailed survey and administrative data to examine the sociodemographic and

educational characteristics related to persistence across both the coursework and apprenticeship phases of the LaunchCode program through generalized ordered logistic regression models. We examined how motivations for applying to the program were related to persistence across both the coursework and apprenticeship phases of the program. Given our focus on equity, we also examined various barriers and facilitators to persistence and how these differ across gender and race/ethnicity. Finally, we examined the experiences of both persisting and non-persisting students across the coursework and apprenticeship phases of the program through semi-structured interviews.

Findings

Our generalized ordered logistic regression models revealed that sociodemographic and educational characteristics were linked to persistence. Test scores and prior coding experience were significantly associated with persistence in both the coursework and apprenticeship phases of the LaunchCode program. However, educational attainment was not significantly associated with persistence in either of these phases. Despite LaunchCode removing some structural barriers, acumen and experience in computer science still appear necessary for program persistence.

When accounting for all other factors, we observed that Black students are more likely to complete the apprenticeship component, suggesting that alternative STEM programs may represent vehicles for racial equity in STEM. Older age was also associated with apprenticeship completion. While older students may have additional work experiences that allow them to succeed in the apprenticeship, they may have additional responsibilities that make them more inclined to pursue an apprenticeship. Indeed, students who were married with no kids were less likely to complete the apprenticeship, potentially because of having fewer dependents or an additional income stream, allowing them to pursue riskier employment pursuits. When considering that apprenticeships often pay less, these individuals may be more inclined to seek permanent, full-time employment even if it means receiving less support from LaunchCode. This dynamic may also explain why students who lost their jobs were more likely to complete the apprenticeship. Other students, as evidenced by our conversation with Jason, may view the course as supplemental, leading to non-persistence. While the program being free provides access to new students who may have been excluded, it also creates a situation in which

students—particularly those with other educational experiences or credentials—have less skin in the game, and thus may be more inclined to exit prematurely.

The findings regarding mentoring were complex: having mentorship before applying to LaunchCode was associated with decreased odds of course and apprenticeship completion, while having mentorship after applying to LaunchCode was associated with increased odds of course completion but decreased odds of apprenticeship completion. Mentorship may provide individuals with opportunities to learn computer science and find employment outside of the LaunchCode program except for students who receive mentorship after applying, who may receive additional support that helps them complete the course.

Moving onto students' motivations for applying to LaunchCode, we observed that interest alignment is highest among course completers while higher pay, better benefits, and increased stability are highest among non-completers. These findings suggest that, despite representing a vehicle for upward mobility, primary motivations in computer science are important for course completion. Viewing LaunchCode solely as an opportunity for economic advancement does not appear to be related to persistence. This finding is supported by qualitative evidence suggesting that persisting students often had an interest in computer science but were unable or unwilling to commit earlier in their educational experiences.

Concerning barriers and facilitators to persistence, time and course difficulty were the two largest barriers to course completion. Almost half of students cited not having enough time as a reason for non-persistence while over a quarter cited the course being too difficult. Given the abbreviated nature of the LaunchCode program and the overall body of bootcamps, it was not surprising that time was a main factor in non-persistence. Multiple students noted that it was difficult to persist with the pace of the part-time course combined with their other responsibilities. Nevertheless, while lack of time can be a barrier to persistence, having more time can be a facilitator. Despite LC101 being a part-time course, some students were able to dedicate their full-time. For example, Will used his financial flexibility, such as living at home with his parents, to dedicate more time to the program—even creating a special study group for similar students.

While course difficulty did not vary across race and ethnicity, it varied across genders, with more women and non-binary persons finding the course difficult. This may reflect larger educational patterns in which women experience fewer opportunities and benefits in advanced

STEM coursework (Ellis et al., 2016; Riegle-Crumb et al., 2012; Riegle-Crumb et al., 2011; Sevilla et al., 2023). Women, as well as Black and Hispanic, students also experienced larger time constraints and more difficulty securing childcare, which may reflect gendered caretaking roles, as well as racialized financial constraints (e.g., from working multiple jobs, from not being able to afford adequate childcare).

Finally, concerning apprenticeship completion, almost one-third of the students cited finding another job as a reason for non-persistence while almost one-seventh cited low pay. While these findings highlight the pay limitations of the apprenticeship model, they also suggest that non-persistence in STEM preparation programs does not equate to non-persistence in STEM. Rather, many students can independently secure a job without completing the apprenticeship. Although apprenticeships offer benefits like a lower-stakes environment and more time to practice new skills with the assistance of mentors, there are also financial costs as these roles offer lower pay, especially when subsidizing a free course. These findings are also supported by qualitative interviews in which some students reported tradeoffs, where they sought a full-time role when available. Nevertheless, these experiences tended to occur for students who came into the course with prior coding experiences that allowed them to excel at faster rates than others.

Implications

Our study has implications for policies, programs, and practices. Given the salience of prior coding experiences and related HackerRank scores in persistence, alternative STEM preparation programs should consider pre-courses for further skill development, particularly for students who are new to computer science. While LaunchCode has developed "discovery" courses to further prepare students in computer science, similar programs should also consider implementing these pre-courses. Given the salience of interest in our findings, alternative STEM preparation programs should consider additional ways to assess student interest. While LaunchCode gauges student interest in the admission process through basic survey questions and brief interviews, more robust methods to measure interest should be considered. More broadly, as suggested by one of the participants we interviewed, alternative STEM preparation programs should also

consider ways to spur interest in new prospective students, such as LaunchCode's "hackathon" events.

Given the importance of time, alternative STEM preparation programs should also consider additional program structures that allow for deeper engagement with the material. In this regard, LaunchCode has recently developed a full-time immersive program known as "CodeCamp" which has been especially popular among students with no prior experience in coding. To house these immersive programs, LaunchCode has partnered with traditional educational institutions, such as community colleges. However, additional research is needed to understand if these programs increase persistence. Beyond program structures, additional program resources should also be considered. LaunchCode recently designed a "stipend" based program for low-income Black mothers, which allows women to earn a stipend while attending the coursework phase. While these stipends can allow participants to devote more time to these programs, they can also help cover other important expenses, such as childcare. Mentoring and coaching models should also be explored as ways to increase persistence. While LaunchCode has designed a range of mentoring supports, more research is needed to understand their effectiveness. Finally, given the high rates of non-persistence, incentive-based program models should be explored. Given the free costs of the LaunchCode program, incentives can serve to boost persistence for students with little "skin in the game".

Limitations

Although our study offers novel contributions to researchers and policymakers, it is not without limitations. As noted by Jabbari et al. (2023), while LaunchCode is one of the first and largest coding and apprenticeship programs in the world, it is nevertheless unique in its programming, particularly with its apprenticeship component. Thus, our findings may not be relevant to other coding programs. Our findings may not be relevant to other non-participating students as not all LaunchCode participants responded to the survey. Nevertheless, as noted by Jabbari et al. (2023), the analytic sample in this study largely resembles the LC101 student body across a host of demographic indicators, such as gender, race/ethnicity, age, and education level. While we offer a descriptive study and do not make any causal claims, some of the characteristics in our models may be correlated with other unobserved and unmodeled characteristics. For example, in the case of barriers and facilitators, there was a substantial number of participants who marked

"other". Even though our qualitative interviews helped uncover additional barriers and facilitators to persistence, it is still possible that other barriers and facilitators to persistence were not captured in our study.

Conclusion

We offer the first quantitative analysis of persistence in a coding and apprenticeship program. Based on labor market trends and the growing needs for workers in the STEM/computational field, these alternative STEM programs will likely continue to increase in the near future. With embedded direct connections to employment and fewer barriers to entry including lower cost and time commitments, these programs can serve to advance efficiency and equity in STEM. However, they are also prone to the same problems of persistence that have plagued traditional STEM preparation programs. By considering the multifaceted factors that influence persistence in LaunchCode, including sociodemographic and educational characteristics, student motivations, and a variety of personal and structural barriers and facilitators, we provide a more comprehensive understanding of persistence in alternative STEM programs. In doing so, our study outlines potential interventions for specific groups and at specific times. More broadly, our study provides actionable insights for designing alternative STEM preparation programs that not only attract but also sustain a diverse and inclusive cohort of learners, ultimately creating a more efficient and equitable alternative STEM pipeline. Nevertheless, this is only the first step. Future research should explore the efficacy of interventions that increase persistence in these programs, especially for those who are currently underrepresented in the STEM workforce such as women and persons of color.

Table 2 Descriptive Statistics of Participants

	Non-completers	Course-	Apprenticeship-	Total
Age Group				
19-34	94 (50.0%)	127 (51.6%)	49 (54.4%)	270 (51.5%)
35-44	52 (27.7%)	79 (32.1%)	34 (37.8%)	165 (31.5%)
45-69	42 (22.3%)	40 (16.3%)	7 (7.8%)	89 (17.0%)
Female/Non-				
Yes	105 (55.9%)	127 (51.6%)	47 (52.2%)	279 (53.2%)
Race/Ethnicity				
White	101 (53.7%)	152 (61.8%)	63 (70.0%)	316 (60.3%)
Black	43 (22.9%)	37 (15.0%)	9 (10.0%)	89 (17.0%)
Asian	14 (7.4%)	28 (11.4%)	9 (10.0%)	51 (9.7%)
Hispanic	5 (2.7%)	8 (3.3%)	1 (1.1%)	14 (2.7%)
Other	25 (13.3%)	21 (8.5%)	8 (8.9%)	54 (10.3%)
Marital & Kid				
Unmarried & no	95 (50.5%)	109 (44.3%)	37 (41.1%)	241 (46.0%)
Unmarried &	20 (10.6%)	25 (10.2%)	8 (8.9%)	53 (10.1%)
Married & No kid	26 (13.8%)	52 (21.1%)	22 (24.4%)	100 (19.1%)
Married & With	43 (22.9%)	60 (24.4%)	23 (25.6%)	126 (24.0%)
Income Quartile				
1st: 0-$20,000	47 (25.0%)	74 (30.1%)	29 (32.2%)	150 (28.6%)
2nd: $20001-	37 (19.7%)	48 (19.5%)	27 (30.0%)	112 (21.4%)
3rd: $34,001-	48 (25.5%)	63 (25.6%)	25 (27.8%)	136 (26.0%)
4th: $47,001-	56 (29.8%)	61 (24.8%)	9 (10.0%)	126 (24.0%)
Employment				
unemployed	37 (19.7%)	58 (23.6%)	24 (26.7%)	119 (22.7%)
Part-time	29 (15.4%)	37 (15.0%)	15 (16.7%)	81 (15.5%)
Full-time	122 (64.9%)	150 (61.0%)	51 (56.7%)	323 (61.6%)
Education (before				
High School or	38 (20.2%)	49 (19.9%)	19 (21.1%)	106 (20.2%)
Some College or	21 (11.2%)	15 (6.1%)	5 (5.6%)	41 (7.8%)
Associate's	20 (10.6%)	19 (7.7%)	10 (11.1%)	49 (9.4%)
Bachelor's	70 (37.2%)	107 (43.5%)	41 (45.6%)	218 (41.6%)
Master's or above	39 (20.7%)	56 (22.8%)	15 (16.7%)	110 (21.0%)
Hacker Rank Score				
Mean (SD)	58.6 (19.9)	65.7 (16.5)	62.2 (15.2)	62.6 (17.9)
Median [Min,	60.0 [0, 100]	65.0 [10.0, 100]	65.0 [15.0, 100]	65.0 [0, 100]

Previous Coding				
None	69 (36.7%)	59 (24.0%)	25 (27.8%)	153 (29.2%)
1-50h	83 (44.1%)	114 (46.3%)	37 (41.1%)	234 (44.7%)
51-250h	22 (11.7%)	45 (18.3%)	17 (18.9%)	84 (16.0%)
251 hours or	14 (7.4%)	28 (11.4%)	11 (12.2%)	53 (10.1%)
Mentorship outside				
None	150 (79.8%)	162 (65.9%)	51 (56.7%)	363 (69.3%)
Received before	26 (13.8%)	21 (8.5%)	13 (14.4%)	60 (11.5%)
Received after	11 (5.9%)	63 (25.6%)	26 (28.9%)	100 (19.1%)
Lost job/income				
Yes	63 (33.5%)	72 (29.3%)	13 (14.4%)	148 (28.2%)
No	125(66.5%)	174(70.7%)	77(65.6%)	376(71.8%)
Own Home (before				
Yes	63 (33.9%)	90 (37.0%)	28 (31.8%)	181 (35.0%)
No	123(66.1%)	153(63.0%)	60(68.2%)	336(65.0%)
Has reliable				
Yes	185 (98.4%)	242 (98.4%)	90 (100%)	517 (98.7%)
No	3(1.6%)	4(1.6%)	0(0)	7(1.3%)

Table 3 *Generalized Ordered Logit Estimates in Odds Ratio*

	(1) *Apprenticed + Course completers* *ref: Non-completers*	(2) *Apprenticed* ref: *Course completers+ non-completers*
Age Group		
(ref: 19-34)		
35-44	.998	.998
	(.226)	(.226)
45-69	.945	3.655**
	(.282)	(1.679)
Female/Non-binary	1.047	1.047
	(.202)	(.202)
Race/Ethnicity		
(ref: White)		
Black	1.106	2.751*
	(.309)	(1.086)
Asian	1.645	1.645
	(.557)	(.557)
Hispanic	1.895	1.895
	(1.066)	(1.066)
Other	.891	2.005
	(.294)	(.846)
Marital & Kid		
(Ref: unmarried & no kid)		
Unmarried & With kid(s)	1.037	1.037
	(.339)	(.339)
Married & No kid	1.512	.419**
	(.415)	(.136)
Married & With kid(s)	.924	.924
	(.236)	(.236)
Income Quartile		
(ref: 1st: 0-$20,000)		
2nd: $20100-$34,000	.635	.635
	(.182)	(.182)
3rd: $35,000-$47,000	.739	.739
	(.212)	(.212)
4th: $48,000-$113,424	.857	1.941
	(.265)	(.827)
Employment (Before LC)		
(ref: unemployed)		
Part-time	.705	1.611
	(.225)	(.64)
Full-time	.982	1.812
	(.266)	(.594)
Education (before LC)		
(ref: High School or Below)		
Some College or Vocational	.806	.806
	(.294)	(.294)
Associate's	.557	.557
	(.202)	(.202)
Bachelor's	.971	.971
	(.247)	(.247)
Master's or above	1.195	1.195
	(.359)	(.359)
Hacker Rank Score	1.017**	1.017**
	(.005)	(.005)
Previous Coding Experience		
(ref: none)		
1-50h	1.637*	1.637*

	(.355)	(.355)
51-250h	1.967*	1.967*
	(.6)	(.6)
251 hours or more	2.481*	1.179
	(.9)	(.502)
Mentorship outside LC		
(ref: none)		
Received before applying to LC	.424**	.424**
	(.131)	(.131)
Received after applying to LC	2.559***	.47**
	(.646)	(.138)
Lost job/income due to Covid	1.323	2.708**
	(.29)	(.944)
Own Home (before LC)	1.26	1.26
	(.297)	(.297)
Has reliable transportation (before LC)	.659	.659
	(.533)	(.533)
Cons	.299	1.045
	(.276)	(.982)
Observations	510	
Pseudo R2	.124	

Note: *Standard errors are in parentheses*; **** p<. 001, ** p<.01, * p<.05; Pseudo R^2=.125*

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