

Emergency funding for women in undergraduate computing: Toward an asset-based model and research framework

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Abstract—Emergency funding may play a critical role in increasing retention and degree attainment for low-income women in computing majors. This study elevates the goals and experiences of women nearing completion of their degrees and sheds light on economic and sociological factors that may impact their persistence and completion, allowing too few to recognize their academic and professional potential. The study provides a bottom-up approach to sharing stories about broadening participation, while establishing larger patterns. Data are from women funded by the Last Mile Education Fund, 711 applications and interviews with 196 of the 305 awardees. Awards totaled \$260,000, averaging approximately \$820 each. Interviews with near-peers on program staff fostered well-being and provided a safe environment for awardees to share their stories and provide data. Quantitative and qualitative results demonstrate the need for emergency funding to increase the persistence of low-income women in computing pathways. They indicate the potentially far-reaching benefits of timely financial assistance and how much economics can shape academic trajectories and student well-being. The study highlights competing demands outside the classroom, choices students may confront, and how COVID-19 changed lives and trajectories. Discussion topics include the adequacy of funding, indicators of financial distress, where emergency funding is most needed, and what solutions may look like for creating a more equitable, diverse and inclusive system for those entering computing fields.

Keywords—*broadening participation, persistence, funding, gender, diversity*

I. INTRODUCTION

A. Broadening participation for low-income women

In recent years, the education community has significantly ramped up efforts to encourage underrepresented students (girls, minorities, students with disabilities, first generation, and low-income students) into computing careers, and now more of these students than ever before are entering challenging engineering and technology-focused majors. With the growing diversity of students entering these computing pathways, there is greater need to innovate around who receives financial support and how they are supported. Every step must be taken to sustain and nurture talented women who are already on the path.

For many aspiring young people from low-income households, a college education is considered the key to economic mobility for themselves and their families, as

graduates earn more over their lifetime and build more wealth than high school graduates [1]. However, affordability challenges for a majority of students suggests the funding system we have may be both broken and unjust. For too many, the journey to graduation day is difficult, uncertain, and financially precarious. Even though 70% of high school graduates enroll in college after graduation, an average of 58.3% of students complete a bachelor's degree within 6 years. In the bottom two income quartiles, only 11% and 20% of students complete their degrees within the same time frame [2]. A related report found affluent students were 8 times more likely to earn a bachelor's degree by age 24 than low-income students [3]. Meanwhile, data from the US Department of Education [4] show that students from the top tier income level are receiving 34% more non-Federal aid on average than low-income students (\$11,300 vs \$7,500), as institutions and merit scholarships focus on "top" talent.

B. Goals for this Paper and Research Questions

While striving for an education, low-income students may lack the guardrails and support from which affluent students benefit. Without a financial safety net, something as small as an unexpected car repair or medical bill can push a student into crisis-level financial insecurity and cause them to forgo or delay their educational pursuits. This research is working toward a theory of change for how emergency and completion funding can impact academic outcomes, and economic and social mobility for potentially thousands of low-income women and their families.

The Last Mile Education Fund (Last Mile) – which funded and provided data for this study – supports self-reported financially vulnerable women who have committed to a technical path, but for whom basic needs insecurity (lack of food, housing, childcare, connectivity, transportation) threaten their progress. This work has grown even more urgent during COVID-19, as job losses and closed campuses have placed increasing numbers of low-income students and women at risk of "falling through the cracks." These may include non-traditional students, parents, or caregivers, DACA students who are ineligible for federal dollars, or international students who are ineligible for many aid and scholarship programs.

This fund was launched by advocates seeking to lower barriers to degree completion and career pathways for women aspiring in computing fields. The goal was to strategically support resilient and persistent students financially, and to support their growth through access to peers, support networks and critical resume building opportunities.

Identify applicable funding agency here. If none, delete this text box.

By removing financial obstacles and offering social encouragement and support opportunities, students may continue down their path feeling uplifted rather than beaten down by circumstances and proud of their accomplishments and abilities as they seek to complete their education and launch their careers. The premise of this work is that ensuring basic needs are met in the critical last four semesters of their college careers can enable these low-income women to succeed. Short-term benefits for awardees are expected to include getting back to their studies, feeling encouraged, relieved and validated. Longer term objectives involve successfully graduating and entering the field, increased earnings and social mobility, ability to give back, and contributing to the technologies and innovation upon which society depends.

Our study of low-income women and college completion is unique because they (1) are pursuing high demand and lucrative fields with a need for diverse talent; (2) have proven themselves by sticking to a challenging major and persisting thus far. These women who are eligible for support through the fund are in the final miles of a marathon. Arguably, by getting this far they have demonstrated the persistence and problem-solving skills needed to be successful in the long run (pun intended). We want to examine to what extent small amounts of funding can help these students overcome obstacles and access opportunities necessary for completing their education and launching into a tech career

This may be a disruptive approach to increasing diversity in computing fields because it addresses critical gaps in financial support for low-income underrepresented students who are within a few semesters of graduation. This involves not just rewarding those who have already been successful, but recognizing what students at this stage in their studies have to offer. Rather than focusing on identifying “top talent” the fund seeks to ensure that capable, committed, striving and often underrepresented students are able to cross the finish line of their education and the starting line for their careers. This can help break the unjust patterns emerging from a society that only rewards the outwardly successful as judged through the lens of the status quo tech workforce and treats inequalities as due to “talent and virtue” [5], a stance that is particularly harmful toward women and communities of color.

As part of its efforts to provide emergency funding to low-income women in computing, the project seeks to build an empirically-supported theory of change that can address these overarching research questions

1. To what extent can emergency funding make a pivotal difference on college persistence, completion and long term success for low-income women in computing pathways?
2. What are the key financial challenges that low-income women must overcome, in addition to their computing studies, and what can we learn about their circumstances and choices?

The following literature review clarifies the importance of this work and helps set the stage for the rest of our investigation.

II. LITERATURE REVIEW

A review of the literature indicates federal financial aid, part-time jobs, and front-loaded scholarships are often not enough to help students finish college. The rising cost of college, the widening wealth gap, along with changing demographics and funding patterns, are putting college degrees out of reach for too many low-income young people and first-generation students. Competing state and federal budget priorities have driven up the costs, creating significant barriers to the point “nearly all flagship institutions are financially out of reach for low-income and even middle-income students” [6]. Recent data indicate that 34.8% of college students are Pell grant eligible [7] (typically a household income below \$50,000), and 85% of all college students overall rely on financial aid to pay for college [8]. Currently fifty-eight percent (58%) of all students and 72% of black college students report experiencing basic needs insecurity during college [9]. In 2019, The Education Trust found that, even with financial aid and working 10 hours per week, and attending a less expensive public college, low-income students would need to pay at least \$3,000 per year to attend a public college in 47 states [10].

Financial aid and college scholarships tend to be front-loaded, focusing on getting students started in college, but often fall off in the remaining years. According to the 2019 #RealCollegeSurvey of 132 institutions, as many as 56% of students with 3 or more years of college report experiencing basic needs insecurity, such as food, housing and healthcare. Rates of basic needs insecurity were highest for marginalized students, while receiving a federal Pell Grant and working during college did not alleviate basic needs insecurity [11].

Research has shown that it is possible to address this problem in ways that might promote more equitable, diverse and inclusive computer science education outcomes. A study of retention grants at Georgia State University found 72% of bachelor’s-degree seeking students had unmet needs, even after grants, loans, scholarships, family contributions, and income from working 20 hours per week. However, after retention funds were provided, 86% of students went on to graduate, indicating positive results that, importantly, were also noted at other schools [12].

Economic insecurity during the final semesters of a college degree is an area that is ripe for examination, because it exposes the flaws in the system that may admit students into programs, but not see enough of them out successfully. There is too often a large gap between costs and the amount of need-based aid that is available. A study by Walizer found schools that were “most likely to underestimate the cost of living off-campus” were two-year and vocational schools, which many low-income students and students of color attend. The same study found financial aid no longer covers the full cost of college for 75% of 4-year college students, leaving a gap many students cannot bridge, averaging \$9000 per year [13]. The resulting financial insecurity can delay graduation, block opportunities for success, and lead to discouragement and disruption; and expiration of financial aid clock eligibility before completing their degrees.

In addition, many low-income students must disproportionately sacrifice precious time and credits to catching up on subjects like math preparation, often placing them out of the sequence for foundational engineering courses

and extending the time required to finish their required courses. Low-income students rarely have the luxury of exploration, indecision or even struggle. To finish within the allotted time, it seems they must be exceptional in almost every respect, arriving at college with a major pre-determined and a detailed plan in place. Academic struggles in first or second year technology or engineering classes can place students out of contention for future internships and scholarships which often require a high minimum GPA for consideration. Even when offered funding to participate in a conference or a highly-competitive internship, there are often financial challenges involving family, travel and lodging expenses, and loss of time at work, that can prevent low-income students from capitalizing on these opportunities.

These issues are exacerbated by the fact that the most selective colleges, that tend to serve disproportionately white and high-income students, spend anywhere from two to almost five times as much on instruction per student than the open access colleges that 70-80% of Hispanic and African American students attend [14]. Yet even at elite Ivy League schools and with full-ride scholarships, low-income students may go hungry or lack funds to travel home on school breaks [15], facing food and housing insecurity when their college shuts down.

Women may be impacted by the above issues in a way that is exacerbated by the economic impacts of COVID-19, because of existing gender inequalities [16]. Based on data from Pew Social Trends and Institute for Women's Policy Research, there are 134,970 women within four semesters of graduation. Of these, approximately 42,100 (31%) are classified as "in poverty" and 29,800 (22%) "near poverty" status [17]. These data suggest that for tens of thousands each year, emergency and completion funding could make the difference between dropping out and completing their degree. This study examines the impact of offering financial support to these young women in high-demand technology pathways, for whom financial distress risks being a determining factor in their computing degrees and careers.

III. METHODS

The Last Mile Education Fund is lifting up the experiences of awardees and using research to draw attention to the importance and prevalence of their stories, in hopes of promoting stronger support systems, more meaningful dialogue, and a better theory of change involving emergency and completion funding. Our research process provides a safe space for students to discuss their situation with near-peers and receive support. This helps awardees explain their needs while providing data on the prevalence of systemic issues that must be addressed to promote more just outcomes at scale.

While individual experiences are kept private, the program has built the necessary infrastructure to leverage data for continuous improvement and impact measurement. Trained near-peers collect data on the impacts of financial stressors on degree attainment, and offer support while seeking ways to learn from and amplify the voices of students. These program staff are stepping into the role of co-investigators with researchers to investigate the nature and extent of student needs, how these intersect with low-income student demographics, and what the nature of the opportunity is when one takes an assets-based approach.

A. Program Launch and Study Population

The fund soft-launched in December 2019, offering bridge and longer-term funding for young women of color attending a selected group of minority serving institutions. During the soft launch, the fund received 50 applications and awarded \$77,000 in support to 16 young women. Upon the onset of COVID-19, and perceiving urgency and demand for emergency funding, the program shifted to offering smaller and faster awards. Because the population of students did not change, only the nature of awards being made available, our research draws on data from both sets of awardees. However, when stories or outcomes are from those who received larger amounts of funds we indicate this in the findings.

Our study draws upon data from the first 839 applications through September of 2020. The program awarded 317 emergency funding awards totaling \$260,000, averaging \$820 each with a median and mode of \$599. After excluding ineligible students from overseas schools, there were 711 eligible applicants. Of these, 56 applied more than once with mixed results (49 of these were eventually funded). For calculating funding rates, each applicant's result is counted once as either funded (at all) or not. Accounting for a few students funded more than once, funds were ultimately transferred to 305 students (a funding rate of 43% for eligible applicants) with 406 declines.

Comparing the proportion of awarded and declined applications suggests the proportions were roughly equivalent for African American or Black applicants (44% awarded), white students (37% awarded), and Native American, Alaskan Nation or First Nation (45% awarded). For the other larger groups, there was a disproportionately higher funding rate for Hispanic students (52% funded, representing 35% of funded and 24% of declined) and a disproportionately lower rate for Asian students (28% funded, representing 15% of funded and 30% of declined), even after removing ineligible students from Indian and Asian (non-U.S.) universities. Awardees included 201 US Citizens; 58 students on F1 VISA, 17 U.S. Legal Permanent Resident (Green Card Holders), 11 recipients of Deferred Action for Childhood Arrivals (DACA) and 18 not answered. Although the numbers were smaller, Native American, Alaska Native or First Nation (N=20) were awarded at a higher rate (45%) than Middle Eastern/North African students (N=17) awarded at 29%. While a few men applied, 100% of awardees were female or non-binary per Last Mile's eligibility requirements.

Follow-up interviews with awardees were attempted after three months. These were designed to offer support and assess the funding and support students had already received. Logs indicate 708 outreach attempts were made to contact the 305 grantees (272 calls, 433 emails). As a result of these efforts, follow-up interview forms were completed for 196 women, a completion rate of 72% for calls made and 64% of awardees overall. Of the 196 who participated, most required several attempts to reach. Less than 3% were reached by phone on the first attempt, with the remainder split between a second attempt and a "close out" final attempt call. In addition, 22 interviews had to be completed using email.

Data on patterns emerging from the application data and follow-up interviews, combined with compelling individual stories, provide evidence of the scope of emergency funding

needs and amplify the voices of awardees. These can provide evidence about where more support is needed, what changes are needed to the current system, and how narratives about college funding in computing fields might evolve. Along with the national data trends, these data shed light on how many young low-income women might succeed in their studies with similar funding in computing fields.

B. Data Collection Methods

This study draws upon the data and insights collected during three stages of the funding process. These include (1) surveys completed during the application process from the beginning of 2020 through September, including interviews with applicants for larger funding requests, (2) Followup phone call interviews with trained near-peers after 3 months, through the end of 2020, and (3) email testimonials, often tied to receiving funding, or through continued correspondence. Taken together the application data, the stories these students tell, and the data from peer interviews provide important information that can contribute to systemic efforts to improve and broaden participation in US colleges and universities.

The Last Mile application form provides guidance on the amount and purpose of funding available and asks for a description of the student's hardship and how the money will help. It also asks for student demographics including citizenship, race/ethnicity and gender as well as academic information such as school name, college major, and anticipated graduation date. The screening process prior to funding includes checking eligibility for financial aid and evidence of having persisted to this point. This means achieving at an acceptable level as indicated by a current unofficial transcript, references, and links to online profiles on sites like GitHub, LinkedIn, etc.

Domestic students were identified as low-income based on being eligible for US Federal Financial Aid/Pell Grants. For International and DACA students, they provided a statement of need. However, fundamentally, Last Mile invests from an abundance viewpoint that believes in students; if they are asking for emergency assistance, we believe they likely need it. Despite research interest in collecting additional baseline data, the application has remained intentionally streamlined to be less burdensome on applicants that are already in distress.

Beyond the online application form, student interactions for follow-up interviews were with trained near-peer staff, including two co-authors on this paper who were able to empathize and relate to them as young computing students of color. These interviews followed protocols to collect more in-depth stories and information on key topics related to academic progress such as anticipated degree date and major, enrollment status, credits needed, etc. Topics discussed included academic and employment status, economic well-being, and a series of basic needs and security questions. These often raised issues beyond what may have initially motivated the application, including concerns related to tuition, rent, housing, transportation, bills, food, medical, basic necessities and expenses, as well as cell phone access, a desktop or laptop and reliable Internet.

The interviews raise questions about whether current awards or requests are sufficient to support completion of their degree. These often prompt the team to inform students about sources of additional financial assistance. Interviews also

check for students' awareness and interest in joining communities of women in computing that are available to help them navigate the intricacies of being a student from underrepresented groups, aiming to become a successful computing professional. These offer additional support and access to networks of peers and mentors.

Project staff also collect email testimonials and thank you messages, which are numerous, as most students want to express their gratitude. These are added to qualitative data, and combined with open-ended responses from interviews and surveys, to create a picture of student experiences that can be informative. Some students have already shared their stories in public forums, but this paper does not identify individuals or their organizations.

While diversity numbers are of great interest, our study takes great care to avoid viewing students as statistics (financials, graduation rates, GPA or test scores), instead centering their stories as a way to understand the challenges they face, the assets they bring to confront these, and their considerable accomplishments. There are no "average" people, and it is too easy to misinterpret available data or promote continued inequality by focusing on existing patterns and findings, as noted in [14]. The indicators and frequency metrics are more valuable if they connect in actionable ways to what individuals are telling us matters to them. In this way, qualitative understandings emerging from student experiences and conversations, are coupled with appropriate quantitative data that provide a broader perspective on their prevalence.

IV. FINDINGS

These findings add to the existing research on challenges and opportunities facing low-income students, with particular attention to economic issues for young women of color who are preparing to enter computing fields. A summary of data from applicants, follow-up interviews, and emails give a sense of the breadth and depth of the issues, and point to what women are already overcoming and can accomplish with timely assistance.

Stories from awardees indicate the impact that being relieved from their financial stress has on women who, at least to some extent, are able to get back to focusing on their academic work. They further suggest that the additional forms of support and encouragement are can be important, with some of the young women potentially believing in themselves more because they see that others, in fact, do believe in them. As one emergency award recipient wrote "This means the world to me, and you have just restored my faith in trying and believing that there is help out there."

Using objective measures, we see students are clearly taking advantage of financial support and resources to help find additional funding, complete their degrees, and launch their careers. Of those contacted who are not currently in school, the study has identified 23 awardees who have graduated and only 5 who are known to be taking time off or having dropped out.

Our research is ongoing but there are already compelling stories to be told about many of key themes we have seen emerge: (1) family issues and priorities, (2) stress and mental health, (3) work demands outside school, (4) housing, (5) education costs (6) food and basic necessities, (7) transportation, (8) immigration, and (9) being unemployed

without needed income. The following sections begin to illustrate the experience of women in our study.

A. *Stories of Challenges and Opportunities*

An initial observation is that the low-income women in our study may limit their view of what is economically possible for them. Consider what this awardee classified as luxuries. "A grant would afford me some simple luxuries that would significantly improve my quality of life. I intend to stock up on nonperishable groceries that aren't always available at the food pantry, purchase a coat, allocate a portion for gas, and look into repairing or replacing my laptop." From our perspective, they often seem to not ask for enough. At least one asked for gas money in order to drive miles to access wifi, rather than for money to purchase wifi themselves.

A key issue is the importance of family as a factor that influences women's ability to be successful economically and in school. Challenges with the family and related hardships, such as a parent losing a job or having to return to work, can create stressful financial or childcare burdens for students. As one awardee wrote "My father lost his job in the embassy because of wars going on in our country and so I had to take off from work to care for my younger siblings while my dad looks for work." Having additional funds allowed her to help her family out financially, care for siblings, and stay focused on her studies. She was able to not work, continue her studies, and apply for additional funding to carry her through.

One way family comes into play is having to work to pay bills for others. As one student wrote: "These past few months were rough because my parents rely on me to use my source of income to help around the house. Being a college student and obtaining full-time employment is a big responsibility, but these few weeks without a job is devastating." It was not unusual to hear students like this discuss having lost their jobs and not qualifying for unemployment. As a result, they lacked a "source of income to help pay for housing, food, tuition, fees, and transportation."

Other stories highlighted financial challenges associated with staying in school. One awardee wrote, "I will be out of school next quarter if I do not raise around 3500 dollars to cover my fall tuition. I have been placed on academic hold and can't register for classes. I am so desperate that I don't know what to do. I come from a life of poverty and my education is the only thing I have going for me. I am an Informatics major and I have overcome so much to get to where I am. I really do not want this to be the end of the road for me. Please help me. I'm not sure if you can help but I am asking because I do not know what else to do."

Another student noted her tuition bill might prevent her from continuing her studies. "I still have a balance of \$1,500 for my spring semester tuition. I am paying out of pocket, but due to the pandemic I unfortunately lost the three jobs that were helping do that. The small amount of money that I have saved I am helping my parents pay for groceries. I am fortunate that next semester I won't pay a lot because my dad will be retired, but if I do not pay the remaining of the tuition I will not be able to go to my last year of undergrad."

This student received an initial emergency grant in Spring of 2020, and then additional support in Fall of 2020 and Spring 2021, which enabled her to graduate in May 2021 and

join the workforce as a software engineer at a major retail chain.

A young woman from a rural Navajo community in New Mexico was a full-time IT student at a local technical university until April 2020. She applied for funding after schools closed down. She wrote about her father's COVID-19 diagnosis, his subsequent hospitalization, and the bills that were piling up without his income. On top of these new financial obligations, being in a rural area without a stable Internet connection made it hard to "find a reliable outlet to do my coursework in a timely manner." She stated "I will use the funds to get the Internet installed at my home, as well as help my family pay for the bills my father usually takes care of."

That fall we heard news. "COVID-19 has made my academic pursuit difficult to continue. It shut my university campus down and I had to move home, two hours away from campus. I should be comfortable learning from the online setup, but I am having much difficulty staying on top of hybrid-online classes. I also have incomplete grades for the Spring 2020 due to the pandemic which I need to complete by November 2020 in order to stay in school. I also lost my father to COVID-19 in April 2020. He was the main provider for our household. Since he has left, much of the financial obligations are put on myself and my mother, who is also a full time student. This pandemic has brought much heartache and pain to our family but we hold each other up the best way we can. The funds I am requesting will be put to use by paying for our house, utilities, telephone, and wifi connection."

The student received a Spring 2020 emergency grant, and in winter was awarded a larger grant of \$2000 to cover her tuition and other expenses. She has since completed her Associate's degree. She is now working on her B.S. in Information Technology, with home Internet access, while Last Mile hopes to serve as a resource to ensure that future obstacles do not get in her way.

As referenced previously, the project theory of change anticipates that asset-based investments such as these will pay off in success stories from resilient women who just needed some financial help to finish their computing degrees. The sustainability for this project in part rests on contributions from those who succeed wanting to give back in a variety of ways, allowing virtuous cycles to develop. We have seen evidence of two successful students already offering, without being solicited, to reinvest in the fund. In addition, all students who have been asked to share their story have enthusiastically agreed to help spread the word.

One example student who may be in a position to give back as a result of Last Mile funding was close to graduating before running into extenuating financial circumstances, like so many in 2020. "Rent has recently increased and I am very stressed about paying and managing things. I have a job lined up as a software engineer post my graduation. I used to work as a tutor to make rent, but that job has been canceled as a result of COVID-19, causing some of my food worries and rent fears." As a result of alleviating her food and housing insecurity, this young woman was able to stay in school, stay focused, and graduate.

Another young woman who has already given back was in her last semester when she wrote: "I can no longer afford to live and I am nervous that I will not be able to pay my rent next

month. I have applied for food stamps because I can no longer afford groceries, but unfortunately I have not heard back from them yet. I have resorted to food banks in order to eliminate my grocery bill, and sometimes my best friend cooks extra meals to help me out...My last semester of college has started and I have never been so stressed, scared, or deprived in my life. In the meantime I have full time interviews and graduation to be thinking about and studying for, but I work like a dog with no break in between. I am truly exhausted and I want to give up. I will assure you that I will not give up, but support like this would make the largest difference in my world. Despite everything, I know that this too shall pass and I cannot wait for the day that I can be of support to another young woman like myself. It will be magical.”

This young woman received one of the larger awards. This covered her rent through the end of the school year, provided grocery gift cards for food, and paid her tuition balance and graduation fees. Last Mile ultimately invested \$8211 to remove the barriers to her success. As a result, this former student is now working full time as a software engineer, crediting the award she received with enabling her to stay on track during the COVID-19 crisis.

The theory that graduates might find ways to give back appears to be playing out in her case as she wrote to the project: “October is the month of giving at [my large company] and since I am a new hire I get a match for my personal giving. Of course Last Mile is my first choice. You guys helped me so much in my collegiate journey and I am so pleased that I can now pay it forward.” In summary, many of the experiences reported in the literature are borne out with these young women, but their perspectives as advanced, low-income computing students can provide additional sources of insight.

B. Prevalence of Issues from Applications

To accompany the above qualitative findings, the application survey (N=711) and interview forms (N=196) provide an overview of data from applicants including the frequency they reported different employment statuses, graduation dates, impacts from COVID-19 and primary financial issues.

TABLE 1. PREVALENCE OF PRIMARY ISSUES ON APPLICATION

Primary Issue	#	Percent
Food	150	47%
Housing / Rent	129	41%
Tech (desks, equipment, wifi)	97	31%
School (tuition, fees, supplies)	76	24%
Bills (phone, electric, misc)	75	24%
Transportation (moving, auto)	30	9%
Health (necessities)	24	8%
Medical and dental	16	5%

On their applications, students who received awards most frequently reported their primary issue involved food (47%), followed by housing or rent (41%). These were followed by technology needs (31%) such as wifi, Internet, computers,

equipment and desks. School costs such as tuitions, fees, and supplies were primary for 24%, while 24% listed bills and miscellaneous costs (Table 1).

Taking all the issues reported on the applications by awardees, not just the primary ones, the most frequent profile of issues involved food & housing combined (40%), school costs alone (31%), housing alone (29%), and technology needs alone (24%). These were followed by food and technology combined (22%), housing and bills (14%), and technology and school combined (12%)

C. Prevalence of Issues from Interviews

Follow-up near-peer interviews with awardees (N=196) conducted after three months addressed ongoing areas of economic insecurity and the impact of COVID-19. These were coded during the interviews to illuminate their circumstances and the economic choices they may have to make, even after receiving funding.

Food & Housing: Nearly half of awardees (47%) expressed concerns about food, while 15% indicated that they lacked stable housing. For the 85% with stable housing, almost half (45%) still sometimes worried about food. This indicates that food insecurity exists almost half the time, for our awardees, even when housing is available. In contrast, for the 53% who have food security (n=106) a relatively small minority (12%) reported they sometimes lack stable housing (Table 2).

TABLE 2. ISSUES ON FOLLOW-UP INTERVIEWS AFTER 3 MONTHS

Among this percent of all awardees	Who had security in these areas after 3 months	This percent	Still reported insecurity about these issues
53%	Food	12%	Housing
85%	Housing	45%	Food
70%	School supplies	14%	Cell phone
85%	Cell phone	27%	School supplies
68%	Internet	7%	Computer
92%	Computer	31%	Internet

School Supplies & Cell Phones: The study asked students about having “all of your books, supplies, and materials” needed for school. Lacking these was a concern for 30% of awardees – 26% who indicated they did not have these, and 4% who only maybe did. In contrast, 15%, said losing their mobile phone access was or was sometimes a concern.

For the 85% with secure cell phone access, 24% indicated they did not have all their school supplies, and another 3% said only sometimes. Meanwhile, for the 70% who had the necessary books and supplies, only 3% said losing their mobile phone was a concern while another 11% did indicate it sometimes was.

Internet & Computers: In the follow-up interviews, 68% of awardees indicated they had reliable Internet access, while 8% did not and another 24% only sometimes did. A substantially larger proportion (92%) reported having a computer (laptop or desktop), with only 4% saying they did not and 4% sometimes.

For those with computers, 31% still lacked reliable Internet access (7% did not have and 24% only sometimes). In contrast, for those who had reliable Internet, 93% indicated they had laptops or computers. As a result, it seems reliable Internet may be a more general and independent concern, while lack of working computers (not to mention computer quality) is still an important issue for too many.

In summary, it seems that more sensitive (“yellow flag”) indicators of economic insecurity may be food, school supplies and Internet access issues. Less frequently seen, but more extreme (“red flag”) issues may include housing, cell phone and computer access.

C. Additional Findings from Follow-Ups Interviews

Employment status/Working in School: Most awardees (65%) were working or planned to work while in school, while 21% indicated maybe and only 14% said no. Hours spent working each week were fairly evenly distributed, with almost half working more than 15 hours. The responses ranged from 10 hours or less (27%), 11-15 hours (21%), 16-20 hours (29%), and greater than 20 hours (20%). This is in addition to school and other responsibilities. For the few awardees who are not working while in school, it is crucial to understand this does not typically mean they get to be “full-time” students, as they may be also caring for family, enduring long commutes, trying to get on the Internet, seeking housing, looking for funds or employment.

COVID-19 and Graduation Dates: Despite all the issues described above, and the onset of COVID-19, the vast majority (84% of 196) reached for follow-up planned to be enrolled in school during Spring, 2021. As a result of the pandemic, one-quarter (26%) of awardees said their graduation date had changed, or might change (13%). The greatest proportion with changed plans were now planning to graduate in Spring 2022 (31%), while 15% had changed their plan to graduate this Fall, 2021 or at a still unspecified date (19%). For those who had not changed their date, most indicated they would be graduating in Spring, 2021 (36%) or the next Spring, 2022 (18%).

IV. CONCLUSIONS

This study provides evidence of the impact of offering financial support to students for whom financial distress could be a deciding factor in their pursuit of computing degrees and careers. As part of our research and decision-making, we have heard students describe the hardship they are experiencing and how it is a barrier to achieving their goals. Initial results show significantly more demand than is available or was anticipated.

Because of the nature of the student population being served, the results may provide insights on the impact and interaction of factors such as socioeconomic status, race, and immigration on the academic success of low-income women. This is particularly important as COVID-19 has plunged more students and women [16] into financial insecurity, heightening the urgency to stem the attrition of high-potential low-income students and women from computing programs.

A. Limitations

Analyses so far have focused on the initial benefits students report, and the primacy of financial needs during the first year of funding and program operation. These may not generalize as the program sustains and grows. More systematic reviews of

qualitative and outcomes data would clarify how support and funding structures influence experiences and outcomes, graduation rates and economic mobility. This would include keeping track of those who our study was not initially able to reach, and seeing whether these awardees potentially had less persistence or success. There is a natural confounding factor that the likelihood of persistence was one of the categories for awarding a grant. These stories may illuminate when financial support near the end of a degree is all they needed, and when other factors, or the interaction of other factors may influence or determine what the results will be.

As compelling as the premise of this project is, that students who have made it so far deserve a chance to finish, the limits of its applicability is worth investigating further. This means paying attention to where and for whom more funding is not the entire answer, or when crucial supports or new issues emerge. Conversations driven by student stories coupled with emerging data and qualitative coding strategies will help clarify where financial or other support are most impactful.

In order to test a more comprehensive and complex theory of change, this research will have to establish longer-term indicators of success, salary and job satisfaction, willingness to mentor, volunteer or invest in a more diverse and gender-equal technology workforce. We will learn more about how rapid provision of financial support for different issues impacts student outcomes as we see more students with the opportunity to stay in school, graduate, and get jobs.

Inclusion of similar analyses for low-income men and funding sources may provide a valuable addition to these discussions. Another topic that this study has not fully addressed is how school-level context produces systemic factors that influence outcomes, particularly conditions for students in schools that tend to be under-resourced and account for the greatest proportion of low-income students [14].

B. Implications

This research seeks to contribute to a model for investing in the assets and strengths of low-income women who have nearly made their way through undergraduate computing programs. Our results add to existing studies demonstrating how often high-potential and committed students fall into a financial crisis, indicating a gap between Federal financial aid and traditional scholarships, and leaving them to face financial insecurity. This places them at-risk of dropping out or delaying graduation, adding difficulties on top of already challenging coursework. Financial challenges can prevent students from growing academically as much as they could, and from taking advantage of crucial networking and skill building opportunities.

These results can help inform the work of advocates for women in computing fields. Although Last Mile starts with emergency and completion funding, the longer term objective is to see women succeed in computing and technology careers, allowing them to be more supportive of each other and the field, and providing data on what is possible and should be expected from schools, programs and funders in order to broaden participation in computing.

This study serves to illustrate the presence and impact of widespread system-wide shortages and inequities that contribute to the need for emergency funding, even in high

demand computing fields. Understanding these issues can help guide retention efforts, and refine policies based on what is just, fair and effective. Some key areas for further consideration and investigation are highlighted here.

Being aware of difficult choices: This research reveals some of the choices low-income women students may have to make between work, family and school, books and phones, housing and food. Our analyses provide a picture of what students go through when economic necessities set in. For example, we saw more going without books and supplies while holding onto their cell phone plans. Findings suggest food insecurity, school books and supplies, and Internet access may be good starting points for understanding if a student is in a position to benefit from support. However, when a student is losing housing, cell phone access, or does not have a computer these are even more concerning indicators.

Steering toward success: Providing near-peer support with links to resources and support networks is central to Last Mile's effort. A number of awardees shared their appreciation for being put in touch with networks and additional resources. Some of our efforts have been successful at steering applicants and awardees toward additional funding opportunities and resources. As we learn more about women's choices, our program we hope to better identify indicators of impending financial needs and intervene more efficiently before an emergency occurs. With a growing knowledge base, this project may eventually contribute to early detection models and interventions to increase retention and offer better and more timely support for students.

Asking for enough: A key question going forward is how to help low-income students ask for and receive the financial support they need. Too many students are doing too much with too little. This means going without the kinds of resources that people with unrecognized privilege may take for granted. One conceptual area to investigate is how students (and funders) perceive what is subjectively and objectively sufficient in terms of economic security, access to food, instructional resources, or peer and mentoring support. It seems important to problematize what low-income students may perceive as necessary or sufficient. For example, only 4% of awardees said "maybe" they had the resources they need for school, and yet from an educational research perspective the resources may not be sufficient unless they are producing positive learning experiences. Similarly, with technology access, low-income students' satisfaction with Internet access on the survey responses could be tested with objective speed tests. These and clear indicators of laptop quality, for instance, may clarify what is considered necessary or sufficient. In each of these cases, deeper conversations with awardees are leading to improved understanding. In response to computer quality issues, Last Mile has already launched a device program in 2021 so that upgrading equipment is not a concern for these students.

Putting opportunities within reach: Due to lack of funds, many low-income computing students might have to miss out on learning activities and opportunities, including activities meant to help broaden participation. There are hidden costs in participating in resume-building opportunities, conferences, organizations, and networking opportunities, even when funding is provided. Last Mile is working with partners to provide awardees with free memberships and other perks. We are listening to what awardees subsequently say about the

value of the extra social support and peer networking in addition to the funding.

By sharing and building on these findings together, our work and research seeks to inform a growing community of awardees, partner organizations and schools to build and curate quality solutions and resources. Beyond the benefits of funding we want to learn how to open opportunities, communicate benefits of participation in computing for women, their families, communities, and organizations. This fits in with the work of advocate groups for other historically marginalized communities, and universities who have an interest in gathering knowledge and sharing effective practices. Not unlike Waisome, Jackson and Gilbert [18], in their work with black Ph.D. students, we want to help break down the "isolation, lack of community and lack of strategies" for low-income women completing computing degrees.

The study has explored how emergency funding can contribute to academic retention and greater participation in professional growth activities for low-income women pursuing computing degrees. Evidence is emerging that awardees are completing degrees and starting to get hired as a result of having overcome barriers and graduated. Partner organizations and colleges may benefit from learning about Last Mile and working with us to better understand how to wisely invest more and in ways that can ensure the success of more of their students and alumni. Ultimately the project seeks to create sustainability through a virtuous circle of investment, engagement, reinvestment, and knowledge sharing to help lift up more low-income women so they can graduate and enter into computing fields.

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REFERENCES

1. J. Ma, M. Pender, M., and M. Welch, M., "Education pays 2019: The benefits of higher education for individuals and society," College board-Trends in higher education series, 2020, Accessed: Feb. 5, 2021. [Online]. Available: <https://research.collegeboard.org/pdf/education-pays-2019-full-report.pdf>.
2. M. Cahalan, L.W. Perna, M. Yamashita, J. Wright, J., and S. Santillan, "2018 Indicators of higher education equity in the United States: Historical trend report". The Pell Institute for the Study of Opportunity in Higher Education, Council for Opportunity in Education (COE), and Alliance for Higher Education and Democracy of the University of Pennsylvania (PennAHEAD), 2018, Accessed: Feb. 5, 2021. [Online]. Available: http://pellinstitute.org/downloads/publications-Indicators_of_Higher_Education_Equity_in_the_US_2018_Historical_Trend_Report.pdf.
3. M. Cahalan and L. Perna, L., "Indicators of higher education equity in the United States: 45 year trend report," The Pell Institute for the Study of Opportunity in Higher Education, Council for Opportunity in Education (COE), and Alliance for Higher Education and Democracy of the University of Pennsylvania (PennAHEAD), 2015, Accessed: Feb. 5, 2021. [Online]. Available: <https://files.eric.ed.gov/fulltext/ED555865.pdf>.
4. The U.S. Department of Education, National Center for Education Statistics, "Trends in undergraduate nonfederal grant and scholarship aid by demographic and enrollment characteristics: Selected years, 2003-04 to 2015-16", 2019, Accessed: Feb. 5, 2021. [Online]. Available:<https://nces.ed.gov/pubs2019/2019486.pdf>.

5. Sandel, M. (2020) *The tyranny of merit: What's become of the common good?* New York: Farrar, Straus and Giroux.
6. K. Mugglestone, K. Dancy, and M. Voight, "Opportunity lost: Net price and equity at public flagship institutions." Washington, DC: Institute for Higher Education Policy, 2019 Accessed: Feb. 5, 2021. [Online]. Available: http://www.ihep.org/sites/default/files/uploads/docs/pubs/ihep_flagship_afford_report_final.pdf.
7. The U.S. Department of Education, National Center for Education Statistics, "Trend generator: Financial aid: What is the percent of undergraduate students awarded Pell grants?," 2021, Accessed: Feb. 19, 2021. [Online]. Available: <https://nces.ed.gov/ipeds/TrendGenerator/app/answer/8/35>
8. The U.S. Department of Education, National Center for Education Statistics, "The Condition of Education 2020 (NCES 2020-144), Sources of Financial Aid," 2020, Accessed: Feb 19, 2021. [Online]. Available: <https://nces.ed.gov/fastfacts/display.asp?id=31>
9. S. Goldrick-Rab, E. Conroy, and S. Magnelia, "Emergency aid during the pandemic." Philadelphia, PA: Temple University, The Hope Center for College, Community, and Justice, 2020, Accessed: Jan. 20, 2021. [Online]. Available: https://hope4college.com/wp-content/uploads/2020/07/Gates_EA_infoSession.pdf
10. A. Marshall, A.H. Nichols, and J.O. Schak, "How affordable are public colleges in your state for students from low-income backgrounds?," The Education Trust, 2019, Accessed: Jan. 20, 2021. [Online]. Available: <https://edtrustmain.s3.us-east-2.amazonaws.com/wp-content/uploads/2014/09/18122721/How-Affordable-Are-Public-Colleges-in-Your-State-for-Students-from-Low-Income-Background-December-2019.pdf>
11. S. Goldrick-Rab, C. Baker-Smith, V. Coca, E. Looker and T. Williams "College and University Basic Needs Insecurity: A National #RealCollege Survey Report," The Hope Center for College, Community, and Justice at Temple University, 2020, Accessed: Jan. 20, 2021. [Online]. Available: https://hope4college.com/wp-content/uploads/2019/04/HOPE_realcollege_National_report_digital.pdf.
12. C.B. Anderson & P.E. Steele, *Foiling the drop-out trap: Completion grant practices for retaining and graduating students.* Coalition of Urban Serving Universities and the Association of Public Land Grant Universities. <https://www.aplu.org/library/foiling-the-drop-out-trap-completion-grant-practices-for-retaining-and-graduating-students/file>
13. L. Walizer, "When financial aid falls short: New data reveal students face thousands in unmet need," The Center for Law and Social Policy, 2018, Accessed: Jan. 20, 2021. [Online]. Available: <https://www.luminafoundation.org/wp-content/uploads/2019/01/when-financial-aid-falls-short.pdf>.
14. A. Carnevale and J. Strohl, "Separate and unequal: How higher education reinforces intergenerational reproduction of white racial privilege," Georgetown Public Policy Institute, 2013, <https://cew.georgetown.edu/cew-reports/separate-unequal/> (accessed Feb 15, 2021)
15. N. Anderson, "For the poor in the Ivy League, a full ride isn't always what they imagined," *Washingtonpost.com*. https://www.washingtonpost.com/local/education/for-the-poor-in-the-ivy-league-a-full-ride-isnt-always-what-they-imagined/2016/05/16/5f89972a-114d-11e6-81b4-581a5c4c42df_story.html (accessed Feb 19, 2021)
16. A. Madgavkar, O. White, M. Krishnan, D. Mahajan & X. Azcue, "COVID-19 and gender equality: Countering the regressive effects" McKinsey & Company, 2020 <https://www.mckinsey.com/featured-insights/future-of-work/covid-19-and-gender-equality-countering-the-regressive-effects>
17. R. Fry and A. Cilluffo, "A rising share of undergraduates are from poor families, especially at less selective colleges." Pew Research Center. <https://www.pewsocialtrends.org/2019/05/22/a-rising-share-of-undergraduates-are-from-poor-families-especially-at-less-selective-colleges/> (accessed Feb 12, 2021)
18. J.A. Waisome, J.F. Jackson & J.E. Gilbert, *The iAAMCS Ecosystem: Retaining Blacks/African-Americans in CS PhD Programs.* In 2020 Research on Equity and Sustained Participation in Engineering, Computing, and Technology (RESPECT) (Vol. 1, pp. 1-4). IEEE.