Creating Pathways of Belonging and Achievement: Lessons from WPI's PASS-CS Program (Experience)

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Abstract. At Worcester Polytechnic Institute (WPI), we have spent the past decade developing programs that help students from low-income and first-generation backgrounds find their footing and thrive in STEM. In this paper, we reflect on what we have learned from implementing the Path to Achieving Success and Sense of Belonging in Computer Science (PASS-CS) program, which is a National Science Foundation S-STEM founded program. PASS-CS brings together several supports mechanism for students: a summer mini-bridge that helps students prepare academically and socially for college, shared course schedules that keep cohorts together in key classes, near-peer study groups, mentoring from both faculty and peers, and professional development opportunities that help students begin to see themselves in STEM careers. From our first year of implementation, three themes stand out. Early cohort-building experiences help students feel connected and part of a community. Structured academic supports like study groups and mentoring strengthen both confidence and performance in first-year calculus and programming courses. And consistent mentoring relationships with faculty and peers provides guidance and accountability as students navigate college life. Overall, we found that when students feel connected and supported, their academic success tends to follow. In this paper we share the challenges we encountered, the lessons we learned, and how this work continues to evolve.

Introduction

Worcester Polytechnic Institute (WPI) is a mid-size private research university in Worcester, Massachusetts, newly designated as "R1" in the Carnegie classification of institutions of higher education [1]. In the last decade, faculty and administrators on campus have worked together to build programs that support first-generation and low-income students to succeed in Science, Technology, Engineering, and Mathematics (STEM).

In 2018, WPI was awarded a National Science Foundation Scholarships in STEM (S-STEM) grant titled "Renewable Energies Materials Scholars STEM" (REM-STEM) which opened the door to new student-support focused programming on campus. In 2019, WPI created the *Great Minds Scholars* scholarship to provide students from Worcester Public Schools and low-income backgrounds access to a world-class STEM education. The initial cohort of 10 students received full tuition scholarships, but the program lacked dedicated housing support and comprehensive wraparound services. Recognizing these gaps, WPI applied for and was awarded in 2020 another NSF S-STEM grant titled "Connecting Mentor Partners for Academic Success of Undergraduates in Science, Technology, Engineering, and Mathematics" (CoMPASS). This grant provided

housing stipends and just-in-time programming to support the social, emotional, and academic growth of scholars, serving two cohorts beginning in 2020 and 2021 with four years of comprehensive support [2, 3, 9].

Building on the success of REM-STEM, *Great Minds Scholars*, and CoMPASS, WPI was awarded a third S-STEM grant in 2023, "Path to Achieving Success and Sense of Belonging in Computer Science" (PASS-CS), which welcomed its first cohort in Fall 2024. The PASS-CS program serves Pell-eligible students who apply based on their interest in participating in structured supportive programming. With cohorts of 10, 10, and 8 students entering in 2024, 2025, and 2026 respectively, PASS-CS significantly expanded the infrastructure developed through CoMPASS to create a more comprehensive support ecosystem.

The PASS-CS project introduced several key programs including a summer mini-bridge that feeds directly into WPI's existing *Connections* pre-orientation program, sub-cohort scheduling in calculus and introductory computer science classes, near-peer mentoring, and dedicated tutoring. The program features weekly faculty-led meetings throughout the fall semester focused on student success and transition strategies, with differentiated faculty mentor engagement at each class level (first-year through senior year). These structured supports are integrated with partnerships involving key university units. The lessons learned from both grants continue to inform and strengthen the home-grown *Great Minds Scholars* program, creating a sustainable model for supporting low-income STEM students at WPI.

1.1 Context about Worcester Polytechnic Institute

Worcester Polytechnic Institute serves a little over 5000 undergraduate and 1700 graduate students [4]. At the undergraduate level, computer science is the most popular major followed by five engineering majors: mechanical engineering, robotics engineering, electrical and computer engineering, aerospace engineering, and biomedical engineering [4]. Because computer science attracts the largest share of undergraduate students, it is also where institutional efforts to improve retention and student success can have the largest impact, particularly for students who enter the university with fewer financial resources and encounter compounding academic and economic pressures.

In the Fall of 2025, 92.16% of WPI's undergraduate population was made of U.S. citizens or permanent residents, an increase from the 87%-89% typically enrolled before the COVID-19 pandemic [4]. Over 99% of full-time WPI undergraduate students receive financial aid from federal, state, and institutional sources (including need and merit-based aid). In academic year 2025/2026, 14.96% of full-time undergraduates (817) received and used a Pell Grant; this number has recently increased to surpass pre-pandemic levels [4]. For many Pell-eligible and other low-income students, finances in college can translate into additional time burdens (e.g., work obligations) and reduced flexibility to recover from early academic setbacks. This institutional context is a key reason this grant targets computer science students from low-income backgrounds.

When considering National Center for Education Statistics' Integrated Postsecondary Education Data System (IPEDS) classifications, the demographic characteristics of WPI's undergraduate population are similar to those of students at peer institutions. An overwhelming majority of enrolled students identifies as White (~62%), around 12% as Asian, less than 3% as Black or African American, and less than 9% as Hispanic or Latino [4]. The undergraduate gender ratio has seen a sharp decline in recent years, and in Fall 2025 only about 29% of full-time students identified as women [4]. These patterns show the importance of strengthening pathways for students who face structural barriers to retention in STEM fields such as computer science.

In the 1970s, WPI implemented an unusual academic calendar to support "The WPI Plan," its newly developed project-based learning curriculum aimed at creating "technical humanists" [5, p. 106]. Undergraduate courses run for 7 weeks, and each semester consists of two 7-week terms: A and B terms span the Fall semester separated by fall break, and C and D terms span the Spring semester separated by spring break. Standard undergraduate enrollment consists of three courses per term for a total of 12 courses per academic year.

2. The PASS-CS program

The primary goal of the "Path to Achieving Success and Sense of Belonging in Computer Science" (PASS-CS) program builds upon WPI's strategic mission to "transform lives" whereby a degree from WPI is an effective engine for social mobility. PASS-CS focuses specifically on computer science because it is WPI's most popular undergraduate major [4] and a high-value pathway to mobility, yet low-income students can face disproportionate barriers to persistence in the major without targeted support. We are piloting interventions and institutional shifts to close the gap in retention and graduation rates of computer science students from low-income backgrounds compared to non-Pell students.

Our goals include: (1) financially, academically, and emotionally supporting PASS-CS scholars with holistic, intentional, and evidence-based programming designed to help students adapt over time from their first day on campus, to succeeding as a college student, to becoming a computer science professional; (2) developing and implementing an asset-based framework with a comprehensive mentor network (e.g., peer, faculty, and staff) and workshops that lead to sustainable, institutional change to support computer science students from disadvantaged socio-economic backgrounds; and (3) examining ways in which institutional and student assets interact over time to support student retention and graduation.

The PASS-CS NSF S-STEM grant offers each scholar up to $15,000 yearly for four consecutive academic years. This financial support is geared towards offsetting unmet financial need as identified by WPI's Financial Aid office. Financially supporting scholars from low-income families aims to reduce the pressure to work during the academic year, allowing them to focus on academics and connecting with the community. Because computer science courses can be time-intensive and cumulative, reducing non-academic work hours and increasing access to structured

mentoring and support can directly help scholars remain on track academically while building a sense of belonging within the computer science community.

2.1 Grant programming in academic year 2024/2025: The first cohort of PASS-CS scholars

Mini-Bridge. In a three-day, pre-orientation summer program, led by PASS-CS faculty from computer science, mathematical sciences, and physics, the 10 scholars iterated through three stages of metacognitive scaffolding: dreams, goals, and plans. Alongside the faculty leads, the mini-bridge also employed three near-peer mentors—upper-class students in computer science-related fields paid hourly to help guide the PASS-CS scholars and connect with them during and after the planned daily programming. These mentors continued working with the cohort throughout the Fall.

In addition to logistics of the PASS-CS program and grant criteria, on the first day of the mini-bridge, scholars were asked to find reflections of themselves in profiles of computer scientist professionals to set expectations for themselves without having to answer the question "what do you want to do after graduation?" [6]. The expectation-setting was intended to dispel common tropes about who is a typical computer scientist, what it means to do computer science, and erroneous inferences that computer science is synonymous with software engineering or Big Tech. Then, scholars completed a campus tour scavenger hunt which focused on the metacognitive goal of belonging. To ensure that connecting with the campus community was a priority for the cohort, we asked students to seek out potential study and communal spaces in a variety of buildings and campus areas that met certain criteria. Scholars took pictures of their favorite new spaces to be included in their end-of-program presentation meant to report on their dreams, goals, and plans.

On day two, we had scholars reflect on past experiences of productive (and unproductive) successes and failures [7]. Often, first-year students focus on tangible measures of success like grades, so we framed success in STEM by separating short-term benefits (such as productiveness) with long-term benefits (such as success). This deliberate reframing aligns with grant priorities of increasing retention and graduation rates for low-income computer science students (rather than focusing on their class grades) and was leveraged to guide conversations about cheating, office hours, study groups, and the relationship between work produced and time spent. Scholars performed a brainstorming activity with affinity diagraming on emotional well-being, recognizing patterns of stress, and what actions to take under the label of "self-care." Students—having reflected on potential hurdles they might face under a fast-paced academic workload—were audience to a panel of current students in computer science moderated by faculty in the department; scholars then had a chance to interact with panelists one-on-one.

Finally, the cohort was asked to turn what they learned into concrete, actionable plans in the form of SMART goals for their first year as college students [8]. Students were guided to frame their goals so that PASS-CS faculty could follow up with them over the course of their first fall semester on campus. These included but were not limited to club membership, attending office

hours and building relationships with faculty and upper-class peers, and discovering research and internship opportunities. On the last day, we gave a short preview of the first programming assignment from the introductory computer science sequence, and then scholars were given time to finish their dreams, goals, plans presentations. The mini-bridge program ended with two activities: the scholar's presentations of their dreams, goals, and plans, and a lunch and informal conversation with alumni. A post-mini-bridge focus group run by the external evaluator for the PASS-CS grant underlined how participants found the events involving alumni, faculty, and upper-class students particularly helpful, with one scholar reporting that they "felt like [they had gained] a head start with staff and faculty." Scholars also shared that "the panelists helped create a pathway to success in your brain" and feeling like they "really benefited from [alumni]'s advice on what they would do differently and not."

Weekly workshops. Throughout the fall semester, weekly cohort-wide meetings were held on Wednesday afternoons (3-6PM) in a reserved library space and snacks were provided. These meet-ups gave students time for open-ended mentoring and tutoring with the three hired near-peer mentors (paid hourly) and planned success workshops with faculty leads; all faculty involved in PASS-CS programming are financially compensated based on their time commitment and contributions. The weekly activities for A-term (first half of the fall semester) included time-management and planning skills, introductions to the scholars' computer science faculty mentors, progress reports on their SMART goals, strategies for thriving in group work (as many of them would start doing pair-programming in their introductory computer science courses), major-specific academic advising in preparation for spring class registration, discovering clubs and activities on campus, and understanding the humanities requirements (all WPI students graduate with the equivalent of a Humanities & Arts minor regardless of their major).

In the spring of the first year, we reduced the number of workshops and structured cohort-wide activities to encourage students' independence and reduce their workload. However, we aimed to maintain the sense of community built amongst cohort members during their first semester at WPI and noticed the need for additional structure to support the scholars' academic success, particularly in mathematics courses. During a focus group run towards the end of the first semester by the external evaluator of the PASS-CS grant, one student mentioned that the weekly meetings with friends "help you feel like you're not alone and struggling." As such, we invited students to continue taking advantage of our standing three-hour reservation for the library space offering snacks and near-peer mentor support on a weekly basis and scheduled only a few cohort-wide workshops per term.

One-on-one advising check-ins. In the spring of the first year, we introduced one-on-one check-ins with PASS-CS faculty to offer individualized support, particularly to those who needed it most. Five faculty met individually with two scholars each on a term-basis (or more often, if needed) to check-in on their progress and offer advice, support, and resources.

2.2 Challenges and lessons learned in the first year

As mentioned, the scholars' performance in calculus courses during the Fall of 2024, along with explicit student feedback received in surveys and focus groups, indicated a significant need for more mathematics support. While near-peer mentors had already been an integral part of the mini-bridge and weekly workshop structure throughout the first semester, we had initially hired mentors pursuing a degree in computer science thinking that students would need the most support in their major's classes. To address the cohort's needs, new dedicated near-peer mentors (both seniors majoring in mathematics) were hired to provide help with mathematics courses in the Spring of 2025. This change to the PASS-CS support structure was welcomed by the scholars, so we sought out similarly skilled peer-mentors for academic year 2025/2026. Thus far this year our choice of near-peer mentors has paid off with both the new first-year as well as the now sophomore cohorts. As such, we plan to keep this structure in place for the remainder of grant programming.

As discussed above, we reduced the number of structured cohort-wide activities in the Spring of 2025 to give the scholars more chances to bond, build community, work together on class assignments, and interact with the near-peer mentors. However, initially the lack of scheduled workshops caused dwindling in attendance at the weekly cohort meetings. As such, we implemented clear communication guidelines for grant programming to ensure students understood participation expectations and the resources at their disposal.

Based on feedback collected through anonymous online surveys and evaluative focus groups, the first year of PASS-CS programming led to three main takeaways. (1) Early bonding and cohort-based experiences help students feel part of a community and develop a strong sense of belonging. Starting on campus early with the mini-bridge allowed students to get to know each other in a small-group setting and create connections with peers before participating in large orientation activities. We worked with Academic Advising to place scholars in the same course sections as much as possible during their first year, so that the built-in support system of the PASS-CS cohort would extend to academics. We had a very diverse group of scholars from a variety of backgrounds, and yet students built strong bonds that continue to this day. For example, many of them chose to room with PASS-CS peers in their sophomore year.

(2) Structured academic enrichment activities, such as study groups and peer and faculty mentoring, help build students' confidence and performance in first year courses. While WPI offers a variety of free resources and support for all students, the small-group feel of the PASS-CS cohort activities made it easier for students to engage with programming. During a focus group run by a faculty lead, when commenting on how being part of the PASS-CS cohort helped with computer science courses, scholars brought up how starting off their academic experience at WPI with a group of people working together all at the same level was really useful, especially since the program provided a built-in space to do so (i.e., the Wednesday cohort meet-ups). In particular, tailoring the topics and mentoring support to their needs made the students feel heard and cared for, in turn fostering their academic success and sense of belonging on campus and in the field of computer science.

(3) Consistent mentoring relationships between faculty and scholars, as well as between peers, provides a valuable source of accountability and guidance that helped students navigate college life. Several scholars struggled in at least one of their first-year courses. The existing PASS-CS infrastructure naturally provided them with a built-in cohort of peers who were going through the same experiences; upper-class near-peer mentors who could offer academic support and advice on how to navigate these difficult courses; and faculty who could share resources and make suggestions on how to overcome obstacles, academic or otherwise. During the aforementioned focus group run by a faculty lead, scholars reported how connecting on a personal level with upper-class students in the near-peer mentor roles helped them succeed in classes because it translated into being able to ask and get help beyond the structured cohort meetings.

2.3 Grant programming in academic year 2025/2026: Welcoming the second PASS-CS scholars cohort

Going into the second year of the grant, the programming had to be tailored to two separate cohorts, each with its own needs: a new first-year group of 10 scholars, along with the continuing 10 sophomores.

New first-year cohort. While many of the activities from the first mini-bridge were carried over to the second year, some key changes were made. We adjusted the schedule and format of workshops to incorporate more active engagement for the students, minimizing lecture-style presentations, and providing more strategically placed breaks between sessions. A recurring piece of feedback students from the first cohort gave concerning their mini-bridge was that they had hoped to learn material for their first-term classes. While our focus for the second mini-bridge remained on metacognition, navigating college, and taking advantage of resources on campus, two sessions were added in response to this feedback: a brief introduction to the programming language Racket (which is used in introductory computer science courses at WPI) leading into an activity in which students created their own memes in the interactive Racket shell; and an introduction to recursive computation in the context of approximating square roots (with hints at limits, the subject of their first-semester mathematics courses). We also added a session on "hidden curriculum," in which students read through several sample syllabi for first-year courses and identified what they felt were the most important policies, weighting them in terms of how firm or malleable they felt. Finally, a professionalism workshop on email etiquette and how to request letters of recommendation was incorporated. As was the case in the program's first year, the alumni and student panels were regarded as highlights by the students.

Given the positive feedback from the Fall of 2024, the workshops for the new first-year cohort were kept largely the same. A conscious choice was made to move the session on making the most of office hours from the second to the first term of the semester, in an effort to encourage students to take advantage of this resource sooner rather than later. Thriving in group work was moved to the second term in coordination with staff from the on-campus SWEET center (SWEET = Supporting WPI through Effective and Equitable Teamwork). Similarly, the Humanities and

Arts requirements workshop was moved to the second term and grouped with general advising support, as scholars register for spring courses during B-term (second half of the fall semester).

The first cohort of scholars reported being satisfied with the opportunities provided by PASS-CS to meet and interact with faculty on a personal level and how having mentors on campus helped them understand what being a WPI student entailed. Given the positive feedback, each new first-year scholar was assigned a faculty member from the grant team earlier, so that one-on-one advising meetings could begin right away as the students arrived on campus. The goal remained to have at least one check-in meeting with each student per term, adding more frequent individual interactions *ad hoc*.

Sophomore cohort. New workshops were planned to target the changing needs of the first cohort of students, now entering their sophomore year. Fall 2025 workshops covered the following topics: the application process for an off-campus Interactive Qualifying Project—one of the capstone experiences required of all WPI students—with feedback on application materials provided by a PASS-CS faculty member; preparation for students attending the American Association for the Advancement of Science S-STEM Scholars Meeting which took place in October 2025 in San Diego; navigating the computer science major course requirements in accordance with intended area of focus; and an overview of Research Experience for Undergraduates (REU) mechanisms.

The one-on-one advising check-ins that took place in the Spring of 2025 continued throughout the second year with the same scholar-faculty pairings. Completing all the requirements in the WPI Plan in four years entails careful consideration and selection of courses throughout students' undergraduate careers, so the advising check-ins are just as necessary for sophomore scholars as they were during their first year on campus. While the advising load will grow for PASS-CS faculty members when the last scholars cohort is added in Fall 2026, we feel that this form of one-on-one support is essential for ensuring that students are on track to complete their degree on time and plan to continue offering this resource throughout grant programming.

2.4 Plans for the next academic years

While our current cohorts are in their first and second years on campus, the PASS-CS faculty and staff team is developing plans for their junior and senior years. In this planning phase, our goals include designing activities that maintain the cohesiveness of the cohorts, providing distilled information on challenges students encounter during their last two years of college, career-focused programming, and preparation for WPI-specific requirements such as the Interactive Qualifying Project and the Major Qualifying Project (typically completed in the junior and senior year, respectively).

In a student's junior year, their developing sense of identity within the major may more directly influence the types of classes, projects, and opportunities they choose to pursue. We are developing a workshop for the fall semester of the cohorts' junior year to explore this topic, and

plan to hold sessions late in their sophomore year to lay the groundwork. Given that the junior year at WPI typically includes a term-long, off-campus Interactive Qualifying Project as well as applying for the Major Qualifying Project (to be carried out during the senior year), early-year workshops will include information sessions and activities specifically geared towards teamwork and project-based learning. Later in the junior year, workshops will focus on internship preparation, including how to take full advantage of existing offerings (e.g., university-wide career fairs and discipline-specific resume and career sessions). In addition to academic and career support, we will host sessions on research opportunities, such as REUs and university specific programs.

The senior year at WPI can be very challenging as students typically take predominantly upper-level classes, work through the Major Qualifying Project, and need to figure out their post-graduation plans. We anticipate the cohorts developing increased independence and divergence in interests and will structure the PASS-CS cohort programming and support structures accordingly. Once again, we aim to kick off the academic year with several focused sessions on their Major Qualifying Project experience and the strategic selection of their final set of courses. We will also encourage students to participate in peer mentoring opportunities and department-level opportunities such as serving as peer-learning assistants and graders. Throughout their senior year and their Major Qualifying Project, we hope to lean on the developed relationships between cohort members and members of the PASS-CS faculty team to provide personalized support as scholars move towards graduation.

3. Conclusions

Overall, the last two years of the NSF S-STEM PASS-CS grant have been successful at supporting low-income students majoring in computer science financially, with cohort-based tailored programming, and faculty and peer mentoring. Feedback and evaluative data collection through online surveys and focus groups has shown that students thrived in their small group environment forming long-term bonds and supporting one another through difficult times, academic or otherwise. Individualized faculty attention has fostered students' confidence and sense of belonging on campus and in their major, providing resources and advice when needed. This paper focuses on the PASS-CS program development and implementation; the evaluator's report, focus groups, and survey data are included to illustrate how student feedback informed adjustments to PASS-CS programming. These findings were used to guide program changes and are presented to contextualize decisions rather than to provide in-depth quantitative or qualitative analysis. Detailed analysis of the data collected throughout the first year of grant programming is forthcoming in a separate manuscript currently in preparation for peer-review.

To discuss briefly, across the first PASS-CS cohort (n = 10), our preliminary results point to a clear pattern that students are doing quite well overall. The cohort achieved a course passing rate exceeding 90%—a huge success given the heavy load of mathematics courses often creating barriers for students to continue in the computer science major past the first year. Students performed very strongly in their first computer science course (80% A's, 20% B's), often meeting

or exceeding their own preparedness expectations going into A-term. In terms of mathematics courses—especially early calculus— there is a friction point. Most scholars reported feeling at an average-to-above-average level of mathematics preparation at the start of their first year, yet the grades they earned were uneven (50% earned C's and only 20% earned A's), suggesting a gap between perceived readiness and early performance.

Looking at broader indicators, course failing rates and grade point average distributions suggest that PASS-CS scholars are generally on par with other Pell-eligible and first-year computer science students. While this could be interpreted as limited academic impact of grant programming, the primary goal of PASS-CS is to support retention within the computer science major rather than simply focusing on grades and GPAs. In this respect, the program has had strong early success in retention rate. All ten PASS-CS scholars returned to WPI for their second year and remained in the computer science major. Students who experienced difficulty in individual courses continued in the major, which contrasts with existing common patterns of computer science first-year students leaving the major after early setbacks due to concerns about perceived fit.

These preliminary findings suggest that PASS-CS may play a meaningful role in supporting retention even when academic performance varies across courses. Focus group and end-of-year survey data indicate that scholars reported a strong sense of belonging and positive mentorship experiences within the program. Scholars consistently described the cohort structure, peer relationships, and faculty engagement as supportive factors that contributed to their confidence and motivation to remain in the major. Collectively, these findings provide an encouraging early signal that PASS-CS programming is strengthening students' sense of belonging while also helping to identify areas where targeted academic support may further improve outcomes. We underline that this analysis reflects only current outcomes for the inaugural cohort; additional cohorts and longitudinal data will be collected to evaluate longer-term impacts, including whether scholars ultimately demonstrate stronger grade and GPA outcomes compared to other Pell Grant recipients in computer science.

While some aspects of PASS-CS programming are tailored to specific features of WPI's education (such as, for example, preparation for the Interactive Qualifying Project), the overall project structure could be replicated at other higher education institutions to serve low-income scholars or students from other similar populations. While the WPI context has prompted us to focus on students majoring in computer science, we believe this model would work for other majors in and beyond STEM. Implementing a single-major intervention has the advantage of allowing for targeted academic programming, but our project infrastructure (with some modifications) would also be appropriate for students across a diversity of majors. In particular, the multi-faceted support provided in PASS-CS through the summer mini-bridge, semester cohort-based programming, as well as individualized faculty and peer attention, is particularly suitable to impact the experiences of students with minoritized identities. For example, first-generation students who lack the familial know-how of what a successful college career looks like, could benefit from a similarly structured program. An early introduction to the "hidden curriculum"

through a summer mini-bridge could set these students up for success personally and academically; connecting with an affinity-based cohort provides students with a built-in support network and an opportunity to create long-term bonds before their first year begins. Following up throughout the semester both with cohort programming and one-on-one suits the needs of different students and can provide personalized feedback and mentoring often sorely needed by students who lack outside guidance.

The infrastructure, expertise, and collaborative partnerships developed through NSF S-STEM supported programs have positioned Worcester Polytechnic Institute to expand the PASS-CS model to transfer students. WPI is currently developing a track III S-STEM consortia grant proposal focused on strengthening connections with local community colleges. Specifically, the program aims to provide community college students transferring to an engineering major with the opportunity to benefit from WPI's distinctive educational experiences and the comprehensive support systems necessary for their success. This initiative leverages the proven frameworks of cohort-based programming, faculty mentorship, and cross-institutional collaboration to address the critical transition points that community college transfer students face, ensuring equitable access to advanced engineering education and career pathways.

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