Increasing Humanities and STEM Pipelines: Associations Between Student Characteristics and Academic Outcomes

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Humanities and STEM disciplines may face shortages of college graduates, particularly from underrepresented demographic groups. Using multilevel generalized linear models, we evaluated associations between student characteristics and 6-10-year academic outcomes in humanities and STEM pipelines from associate's major declaration through post-enrollment wages among 92,169 first-time community college students. Nonarts humanities majors were more likely to graduate and begin graduate study. STEM majors earned higher wages after terminating their studies. To increase the output and diversity of the humanities and STEM pipelines, students' early selection of humanities-related majors should be increased, and STEM students' persistence and degree completion should be prioritized.

Keywords: humanities, STEM, transfer, graduation, wages

INTRODUCTION

The humanities (HUM) fields have traditionally played an important role in the development of an adaptive, critically thinking, interpersonally effective citizenry and workforce, essential to the functioning of pluralistic democratic societies (American Academy of Arts and Sciences, 2013; Shulman et al., 2024). In contrast, science, technology, engineering and math (STEM) disciplines are widely valued for their role in driving societal innovation and technological advancement, teaching students the scientific process, and developing students' critical problem-solving skills (Gonzalez & Kuenzi, 2012). For both these groups of important fields, there have been concerns that the postsecondary through graduate education pipelines do not attract enough students, have too many leaks, and are insufficiently diverse (Krebs et al., 2009; Riegle-Crumb et al., 2019; Smith, 2017). We examined both groups of fields in detail, determining which student characteristics of advantage and disadvantage are associated with traversing these two pipelines, including vertical transfer between associate- and bachelor's-degree granting institutions, to identify factors that might help decrease pipeline leaks and increase the fields' diversity. First it will be useful to describe more precisely the two fields.

LITERATURE REVIEW

For this study we employed the National Endowment for the Humanities categorization of HUM fields: archeology, comparative religion, ethics, history, jurisprudence, language, linguistics, literature, and the history, criticism, and theory of the arts (National Endowment for the Humanities, n.d.). The in-demand skills of oral communication, collaboration, critical thinking, and ethics are typically important to HUM studies (Deming, 2015). Public attitudes are generally favorable towards HUM (American Academy of Arts and Sciences, 2020). Although knowledge of HUM among college students may be limited (Dallinger & Mann, 2000), after being provided with a definition of HUM, 95% of adults in a nationally representative survey agreed that HUM should be an important part of every American's education. Similarly, 86% of adults agreed that the HUM fields strengthen democracy, and 73% agreed HUM improves the economy (American Academy of Arts and Sciences, 2020). HUM is widely considered essential to our society's functioning and a necessary continuing focus for higher education (Nussbaum, 1998).

As stated previously, STEM includes the fields of science, technology, engineering, and math, each of which comprise numerous subdisciplines. A survey found that 79% of U.S. adults view science as positively affecting peoples' lives, that scientists and engineers contribute a lot to society (65% and 63% respectively), and that investment in science is worth its cost (71%). Industry groups and governments often state that STEM fields are important, with economic and international success described as dependent on technological innovation. During recent decades, STEM fields have boasted higher rates of employment growth and greater median salaries than nonSTEM fields (Pantic, 2007).

Concerns About HUM and STEM Disciplines' Enrollment, Outcomes, and Diversity

Concerns have been frequently and particularly expressed about enrollment, outcomes, and diversity for both the HUM and STEM fields, with the specific concerns differing for these disciplinary areas (e.g., Krebs et al., 2009; Teitelbaum, 2014; Whitcomb & Singh, 2021).

Concerns that HUM higher education enrollment has been declining have increased in recent years (e.g., Reitter & Wellmon, 2023), and the percentage of all granted bachelor's degrees that were HUM majors has fallen in the United States. However, the total number of HUM and liberal arts degrees granted (including associate degrees) has grown (American Academy of Arts and Sciences, n.d.). This is because the percentage of all associate degrees granted within HUM-related subjects increased from 35% in 2000 to 42% in 2015. In fact, in aggregate, the overall proportion of declared HUM majors at two- and four-year colleges has remained relatively stable since 2007 (Pippins et al., 2019). Finally, the total number of HUM graduate degrees has increased since 1990 (American Academy of Arts and Sciences, n.d.).

Turning to STEM enrollment, between the 2011 and 2021 academic years, the total number of STEM bachelor's degrees increased by 59%, while the number of STEM associate degrees shrank by 4% (National Center for Education Statistics, 2023). During the same period, the number of undergraduate certificates, master's degrees, and doctorates earned in STEM fields increased by 44%, 47%, and 22%, respectively. However, between the 2012 and 2020 academic years, the proportion of all degrees conferred that were granted in STEM fields increased from 16% to 21% for bachelor's degrees, while declining from 9% to 8% for associate degrees (National Center for Education Statistics, 2022b).

Concerns regarding professional outcomes for HUM students, but not STEM students have been expressed. HUM bachelor's-degree recipients earn less in the workforce than other bachelor's-degree recipients (Carnevale et al., 2015). STEM majors, particularly those with graduate degrees, have greater earnings (Carnevale & Cheah, 2018). However, disparities in earnings by major may not be very pronounced. HUM bachelor's-degree holders ages 22-32 years have median incomes of $46K compared to $51K among all bachelor's recipients, and at ages 48-59 years, HUM majors have median incomes of $71K compared to $77K among all bachelor's recipients (U.S. Census Bureau, 2018).

Concerns have also been expressed about limited career options for HUM, but not STEM, majors, concerns that may also not be fully justified. HUM bachelor's degree holders most frequently hold jobs in management, office and administrative support, business and financial operations, sales, and education, in that order (U.S. Census Bureau, 2021). One survey found that the most affluent adults were more likely to use HUM skills in their jobs than the less affluent, and 81% of adults reported frequently using at least one HUM skill in their jobs (American Academy of Arts and Sciences, 2020). Further, unemployment rates are only marginally higher among HUM majors (3.6%) compared to all bachelor's graduates (2.9%), and are lower than for all workers who completed high school but did not attend college (5.1%). Finally, HUM major bachelor's degree holders have reported similar job satisfaction rates (87%) compared to all bachelor's degree holders (90%; American Academy of Arts and Sciences, n.d.).

Additional comparisons can be made about the success of HUM and STEM majors. First, obtaining an undergraduate degree, no matter the discipline, is associated with a higher salary (American Academy of Arts and Sciences, n.d.; Stinebrickner & Stinebrickner, 2014).

Second, STEM and HUM majors differ in terms of students' academic progress through college and beyond. Among STEM majors, 69% of associate- and 48% of bachelor's-degree students exit STEM fields before graduation, with almost half not earning a degree (Chen, 2013). In contrast, former HUM majors have been found to perform similarly or better in comparison to several other major categories in terms of admissions exams for management, law, and medicine graduate programs, and constitute about 25% of holders of advanced law degrees and 7% of those in medicine (American Academy of Arts and Sciences, n.d.). HUM majors' postgraduate opportunities and outcomes can be quite positive.

Third, an accurate concern about HUM and STEM is that people in these disciplines are relatively unlikely to be from underrepresented groups. HUM and STEM graduates and faculty are not as diverse as the overall college population (American Academy of Arts and Sciences, n.d.). For example, in 2022, the proportions of bachelor's degrees awarded to Hispanic and Black/African American students were only16.8% and 9.7%, respectively, for HUM, and 14.6% and 7.5%, respectively, for STEM, compared to 22.9% and 13.1%, respectively, in the overall college population (National Center for Education Statistics, 2023). Ultimately, the relative lack of HUM and STEM student diversity results in less HUM and STEM faculty diversity–few students from underrepresented groups are available to enter graduate study and then faculty positions. This is a concern because faculty diversity is important for education quality and for the academic success of students of all races and ethnicities (Milem, 2003). More specifically, students of color are more likely to achieve academically when faculty of color can serve as their mentors (Bitar et al., 2022). Thus, the relative lack of HUM and STEM faculty of color may be inhibiting the ultimate academic success of all students of color. This situation may be exacerbated by the recent Supreme Court decision inhibiting the use of race and ethnicity in bachelor's college admissions (Sotherland et al., 2023).

Pipeline Progress and Increasing Diversity by Means of Vertical Transfer

College student and HUM and STEM faculty diversity can be increased without using race and ethnicity as factors in traditional bachelor's college admissions by increasing the (vertical) transfer of HUM and STEM students from community colleges (associate programs) to bachelor's programs (Sotherland et al., 2023). Nationally, community colleges enroll almost 40% of undergraduates (Ginder et al., 2019), and these colleges have a greater proportion of students who have experienced social or economic marginalization, including first-generation college students, students from low-income families, and students with minoritized racial/ethnic identities (National Center for Education Statistics, 2022a). Unfortunately, although about 80% of community college students state they want to receive at least a bachelor's degree (usually necessitating vertical transfer), six years after college entry, only about 16% of community college students have achieved a bachelor's (Velasco et al., 2024). For these reasons, vertical transfer can increase the diversity of bachelor's degrees, doctoral degrees, and faculty, in both HUM and STEM (Krebs et al., 2009; Whitcomb & Singh, 2021).

Multiple factors contribute to the low vertical transfer rates. For example, community college students often face the challenge of remedial (developmental) coursework, which is assigned more often in community colleges and which is related to reduced persistence and graduation rates (Bicak et al., 2022;

Logue et al., 2019). Many students do not complete their assigned remedial coursework, especially in mathematics, which is the largest proportion of remedial coursework (Chen & Henke, 2017). Placement in remedial mathematics is negatively associated with taking courses in STEM (Park & Ngo, 2021), thus hindering STEM vertical transfer. Uncompleted mathematics requirements are among the largest challenges potential vertical transfer students face (Chrysanthou, 2016).

Associate of Applied Sciences (AAS) degree programs (largely geared toward specific professions), offered at many community colleges, represent another challenge for (STEM) vertical transfer students. AAS students have greater difficulty transferring AAS credits to bachelor's-degree programs and have lower bachelor's completion rates (D'Amico et al., 2021).

Lack of credit transfer and requirements for additional courses are problems faced by all vertical transfer students, not just those enrolled in AAS programs. In any postsecondary program, many courses apply only to specific majors, causing difficulty for students if they change majors or degree programs. Whether credits attained at a community college will apply to any bachelor's degree can be unpredictable. Coursework misalignment, prior coursework requirements, and audition requirements can result in vertical transfer students needing to take or retake much of a STEM or HUM major's courses (Elliott & Lakin, 2020; Meza, 2019). Such problems have helped spur the development of "guided pathways"—community college course sequences designed to correspond to students' goals and enhance credit transfer (Bailey et al., 2015). The creation of meta-majors with coursework sequences broadly applicable to multiple bachelor's majors, and guided pathways emphasizing sequenced coursework aligned with bachelor's-degree requirements, have been integral parts of transfer pathways reforms (DiLeonardo et al., 2022; Moussa & Bickerstaff, 2019; Schudde et al., 2020).

Additional factors associated with lack of pipeline progress include the college environment, insufficient student support, job and home responsibilities, certain student demographics, low pretransfer GPA, and limited financial resources (Gentsch et al., 2024; Gray et al., 2022; Logue et al., 2022; Wutchiett & Logue, 2024; Zhang et al., 2019). Many STEM vertical transfer programs have been designed to meliorate these challenges (Draganov et al., 2023; Shadduck, 2017). These programs recognize and address the lack of STEM faculty and student diversity. However, there are few HUM vertical-transfer-facilitating programs (Bickerstaff et al., 2020). Only a limited number of HUM pipeline programs have included mentorship, research experience, and bonding experiences with other students (Mellon Foundation, 2018; 2019).

Conceptual Framework: Academic Capital, Habitus, and Student Success

Bourdieu's theoretical framework emphasizing multiple forms of capital (e.g., cultural, academic, economic), fields (social contexts), and habitus (dispositions), as well as the nature of their relationships with certain student characteristics, can help us explain and predict academic decision making and success across different academic pipelines (Bourdieu & Passeron, 1977). Attending college enables students to develop cultural capital, including general academic and subject-specific forms of capital, and to form or hone student habitus (Bourdieu, 1996). However, there can be unequal historical access to cultural, academic, and subject-specific capital, before college, that is related to certain preexisting student characteristics, such as race/ethnicity and family income. Previously accumulated capital can influence how easily or effectively students may access and adjust to new college environments, benefit from learning opportunities, and succeed academically (Archer et al., 2012; Katartzi & Hayward, 2020).

Undergraduate students must ultimately select a major; major-specific capital is often relevant to academic success (Archer et al., 2015). Many STEM fields of study emphasize development of subject-specific expertise and capital (Bourdieu, 2005). In contrast, many HUM fields include greater development of more general cultural and academic capital (for example, embodied in writing and communication skills), facilitating access to a wide range of possible career paths (Bourdieu, 1986). Students, including those with families with less academic and cultural capital, may view favorably direct, more assured paths to careers associated with access to economic capital, paths that may depend largely on field-specific capital and habitus (Sikora & Pokropek, 2021). Thus, students who come from backgrounds not likely to generate capital, such as families with few academic or economic resources, may be relatively more likely to choose majors that will lead to immediate additional capital. Given that subject-specific forms of capital are highly necessary (sometimes explicitly and structurally so) for success in STEM fields, while more general forms of academic and cultural capital may greatly aid undergraduate humanistic studies and overall higher education success, students' major choices may be associated with academic success in the HUM and STEM pipelines.

The Current Study

Despite HUM's and STEM's critical roles in higher education and society, and despite concerns about these specific fields' enrollments and insufficient diversity, research on HUM and STEM vertical transfer success, and thus information about possibilities for increasing these disciplines' vertical transfer pipelines, have been limited. No previous quantitative studies have closely tracked students in the HUM and STEM vertical transfer pipelines, including the variables associated with reaching different points in the pipelines. Therefore, using data from students originating in City University of New York (CUNY) community colleges, we conducted a quantitative study investigating transfer student selection into, and success in, the HUM and STEM pipelines to a bachelor's degree and beyond, including student characteristics associated with that success. Specific research questions included, for both HUM and STEM:

1. How many HUM and STEM students are in the pipeline at key pipeline points?
2. Which student characteristics are associated with declaration of a HUM or STEM major across key points in the associate-to-bachelor's pipelines?
3. How successful are students, at key points in the associate-to-bachelor's pipelines, who have declared HUM-related or STEM-related majors?
4. Which student characteristics are associated with these students' successful vertical transfer, graduation, enrollment in graduate study, and wages?

The overall goal was to obtain quantitative information that would suggest specific interventions for increasing the HUM and STEM vertical transfer pipelines' output and, thereby, increase student success and diversity in the HUM and STEM disciplines.

METHODS AND RESULTS

Data Sources and Data Categorization

The sample included all CUNY community college students who began as first-time college freshmen during fall terms 2012-2016 (a total of 92,169 students). CUNY is an urban, public university system located in New York City (NYC) enrolling over 200,000 degree-seeking undergraduates in seven community colleges offering associate degrees, three comprehensive colleges offering associate and bachelor's degrees, and ten bachelor's-degree-granting colleges. CUNY's large number of vertical transfer students (approximately 10,000 per year) and centralized institutional research databases facilitate transfer research (Vickery, 2023). In the present research, those databases provided information regarding student enrollment, major declaration, and other academic outcomes, as well as student demographic characteristics linked to each student by a unique student identifier. CUNY data were supplemented with enrollment and graduation data from the National Student Clearinghouse (NSC) and with New York State Department of Labor wage data.

CUNY associate-degree students are required to declare a major upon matriculation. However, several CUNY community colleges do not offer majors in specific HUM disciplines, and about a third of new CUNY associate-degree students declare a "liberal arts and sciences" (LAS) major. This is the largest associate-degree major, with the greatest amount of HUM department course taking. In contrast, bachelor's-degree students are not required to declare a major upon matriculation, and almost 14% of new transfer students are initially designated as undeclared. A bachelor's-degree student is also able to declare multiple majors.

For this study, we defined majors inside and outside of CUNY in terms of the six-digit Classification of Instructional Programs (CIP) 2010 codes, the U.S. Department of Education's national taxonomy of educational programs (National Center for Education Statistics, 2010). Given that many hundreds of unique

CIP codes exist, and institutions offer many different majors, we grouped students' majors, based primarily on the first two digits of the CIP codes, into eight categories: HUM, LAS, STEM, the three largest other associate major groups (Business, Health, and Criminal Justice), Undeclared, and Other (for all other majors; see Appendix 1). Within the HUM designation, over 70% of CUNY community college students are classified as studying Visual or Performing Arts. Considering this HUM subgroup's size, and in recognition of these programs' additional application and evaluation criteria such as auditions, we further divided the HUM designation into Visual or Performing Arts (HUMarts) and HUM not visual or performing arts (HUMnonarts). In our analyses in which major declaration was an outcome, we evaluated student characteristics' relationships with the declaration of HUMarts and HUMnonarts majors. More generally, our analyses focused on the HUM, HUMarts, HUMnonarts, LAS, and STEM groupings, with HUMarts and HUMnonarts being subsets of HUM, and LAS considered only at the associate level (because it is a rare, ad hoc, bachelor's major). We chose three-time points during students' academic careers at which to examine their performance as a function of their declared majors: students' initial CUNY associate-program term, vertical transfer students' first posttransfer term, and vertical transfer students' graduation term (or most recent bachelor's term). We also examined students' postcollege wages.

We present results in three sections:

1. Descriptive statistics of the sample's and subsamples' characteristics and outcomes, providing an overall understanding of performance across student groups.
2. Sankey diagrams showing major declaration paths to initial and final-term bachelor's HUM and STEM majors, providing visual information about the size and flow of pipeline paths.
3. Results of multilevel (mixed effects) generalized linear regression models, relating student characteristics with multiple dichotomous academic outcomes: HUM or STEM major selection upon entry to associate-degree programs, successful vertical transfer, declaration of initial HUM and STEM posttransfer majors, declaration of final HUM and STEM posttransfer majors, graduation with a bachelor's degree, graduate school enrollment, and with wage earning.

Descriptive Statistics of Sample and Subsample Characteristics and Outcomes

Table 1 shows the total sample's characteristics, separately for students who initially declared a HUM (HUMarts and HUMnonarts combined), HUMarts, HUMnonarts, LAS, or STEM associate major. Most students were female (52.9%) and, upon initial enrollment, had a mean age of 19.8 years. The largest proportion of students was categorized as Hispanic (43.7%), followed by Black/African American (28.5%), and then Asian (14.3%). Approximately three quarters of the students were PELL grant recipients (72.8%), had been identified as needing remedial mathematics (74.9%), and had attended a New York City public high school (74.7%).

Only 4.3% of the associate students were identified as HUM students upon college entry, and nearly three quarters of those (3.1% of the original sample) were HUMarts students. In contrast, 34.2% and 17.2% of the original sample initially declared a LAS or STEM major, respectively.

In general, initial HUMnonarts associate students performed better academically than other students, including transfer to and graduation from a bachelor's program and beginning graduate study. They also tended to have more family financial resources, and were more often female and identified as having remedial need in mathematics (but not in reading or writing). More initial HUMnonarts students transferred than initial HUMarts associate students, and the HUMnonarts students' transfer rate was higher than for the overall sample. In addition, the bachelor's graduation rate (i.e., graduation by 2022; 6-10 years after college entry) was 33.0% for the subset of initial HUMnonarts associate students, higher than the 22.6% for the total sample. In contrast, the transfer and bachelor's graduation rates of associate students who initially majored in STEM were lower than that of the entire sample.

We also examined characteristics of students who transferred to bachelor's programs, including subsets of students who had HUMarts, HUMnonarts, HUM (HUMarts plus HUMnonarts), or STEM as a final major (Table 2). Regarding major declaration, among students whose final bachelor's major was HUM, only 17.8% had a HUM associate major, but 45.0% had a LAS associate major. However, results for the subsets of HUMarts and HUMnonarts students differed. For HUMarts final bachelor's majors, 26.9% had a HUMarts associate major and 32.6% a LAS associate major. For HUMnonarts final bachelor's majors, only 8% had a HUMnonarts associate major, while 52.7% had a LAS associate major. In addition, 69.6% of bachelor's students whose final major was HUM transferred to a HUM major upon transfer to a bachelor's-degree program. In contrast, for students whose final major was STEM, 54.4% studied STEM upon entrance to their associate degree program (and only 22.4% LAS), and 82.4% majored in STEM upon transfer to a bachelor's program.

In terms of graduation rates, the bachelor's graduation rate was higher among students who ultimately declared a HUM major than among those who did not. Vertical transfer students whose final major was STEM had lower graduation rates than all other students, including lower than HUM vertical transfer students.

Figure 1 depicts students' mean annual wages displayed by final bachelor's major and whether they had received a bachelor's degree. Only students who had transferred to a bachelor's institution, had continuous yearly New York State wages, and had not enrolled in a graduate school program were included. Bachelor's-degree recipients in any discipline had higher mean yearly wages than those of nongraduates in the same discipline.

TABLE 1
ENTIRE STUDENT SAMPLE SOCIODEMOGRAPHIC AND ACADEMIC CHARACTERISTICS, OUTCOMES, AND WAGES

		Initial Associate-Degree Major				
Sample	All Students	All HUM	HUMarts	HUMnonarts	LAS	STEM
N	92,169	3,953	2,897	1,056	31,530	16,126
Student Characteristic	%/M(SD)	%/M(S)	%/M(S)	%/M(SD)	%/M(S)	%/M(S)
Sociodemographic & Academic Background						
Race/Ethnicity[a]						
American Indian	0.5	0.2	0.3	0.0	0.4	0.6
Asian	14.3	9.8	11	6.6	13.2	18.4
Black	28.5	33.4	32.6	35.7	27.3	28.4
Hispanic	43.7	43.2	44	41.1	42.5	40.5
White	13.0	13.3	12	16.6	16.6	12.2
Male[a]	47.1	46.4	50.3	35.6	39.8	69.1
Age [a,c]	19.77	19.26	19.17	19.5	19.57	19.5
Total Family Income (thousands) [a,b]	29.9(34.6)	33.3(43.3)	32.4(37.9)	36.4(57.1)	31.2(35.8)	30.4(34.3)
Remedial Need[a,c]						
Math	74.9	77.9	77.4	79.4	77.4	63.7
Reading	25.0	19.5	21.9	12.7	24.5	22
Writing	31.9	25.8	28.5	18.2	29.7	32.4
High School GPA[a]	75.8(7.5)	75.7(7.1)	75.3(7.1)	76.7(7.0)	76.0(7.4)	76.2(7.8)
Nondomestic High School[a]	6.8	4.5	4.3	5.1	5.2	8.5
Non-DOE[e] nondomestic High School[a]	18.5	18.7	17.1	23	18.8	17.5
Academic Characteristics						
AAS Degree Pursued[a,c]	21.9	24.3	32.9	0.7	0	29
PELL [a,c]	72.8	69.3	70.7	65.4	72.7	70.7
Total Grant Award (thousands) [a,d]	10.1(9.5)	9.6(9.4)	9.6(9.3)	9.6(9.5)	10.3(9.5)	9.7(9.5)
Total Terms[a,d]	4.7(2.9)	4.4(2.6)	4.4(2.7)	4.5(2.4)	4.7(2.9)	4.8(3.0)
Proportion Terms Received Grants[a,d]	69.5	68.8	69.6	66.7	69.9	67.2
Initial-term Credits Passed[a,c]	6.7(5.1)	7.2(5.2)	6.9(5.2)	7.9(5.3)	7.0(5.1)	6.5(5.2)
Initial-term GPA[a,c]	2.3(1.2)	2.3(1.3)	2.2(1.3)	2.5(1.2)	2.3(1.2)	2.3(1.3)

Outcomes						
Transferred to Bachelor's Program[b]	41.7	39.5	35.2	51.3	44.3	40.5
Graduated Bachelor's Program[a,b]	22.6	21.2	16.9	33.0	24.5	20.9
Began Graduate Education[a,b]	4.4	3.9	2.4	8.2	5.6	3.6
1st Year Wage (thousands)[f]	19.5	15.2	14.2	17.7	19.3	19.1
3rd Year Wage (thousands)[f]	23.4	18.4	17.2	22.0	22.9	23.7

Note: Percentages are shown for dichotomous variables, and means with standard deviations in parentheses are shown for continuous variables.
[a]CUNY data.
[b]NSC data.
[c]Values based on first associate-program term.
[d]Values based on all CUNY associate-program terms.
[e]DOE is the New York City Department of Education (DOE) public schools.
[f]Mean yearly wages after entering the workforce for years since last enrolling.

TABLE 2
CHARACTERISTICS OF BACHELOR'S PROGRAM TRANSFER STUDENTS INCLUDING THOSE WITH HUM OR STEM FINAL MAJORS

		Final Bachelor's-Degree Major			
Sample	All Students [a]	All HUM [a]	HUMarts [a]	HUMnonarts [a]	STEM [a]
N	38,394	4,709	1,815	2,894	4,842
Student Characteristic	% or M(SD)	% or M(SD)	% or M(SD)	% or M(SD)	% or M(SD)
Sociodemographics & Academic Background					
Race/Ethnicity[b]					
American Indian	0.5	0.4	0.4	0.3	0.5
Asian	17.9	14.2	18.3	11.7	30.5
Black	25.6	24.3	24.7	24.1	24.0
Hispanic	39.9	44.6	40.7	47.1	29.7
White	16.0	16.5	16.0	16.8	15.4
Male[b]	38.7	39.7	46.7	35.2	65.5
Age[b,d]	19.4(4.1)	19.1(3.9)	19.2(3.9)	19.1(3.9)	19.5(3.7)
Total Family Income (thousands)[b,d]	32.7(36.9)	36.2(40.9)	36.0(42.3)	36.4(40.0)	31.3(34.5)
Remedial Need[b,d]					
Math	65.5	68.8	64.1	71.8	44.5
Reading	20.1	14.7	16.5	13.6	22.2
Writing	25.6	19.5	23.5	16.9	32.8

Academic Characteristics					
AAS Degree Pursued[b,d]	18.0	16.5	22.8	12.5	23.5
Associate's Initial-term Major[b,d]					
HUM	4.1	17.8	28.5	11.2	2.0
HUMarts	2.7	12.4	26.9	3.2	1.7
LAS	36.4	45	32.6	52.7	22.4
STEM	17.0	15.6	21.2	12.1	54.4
Cumulative Credits Passed at Transfer[b]	54.5(19.8)	56.7(15.3)	56.1(17.1)	57.2(14.1)	57.0(20.2)
Cumulative GPA at Transfer[b]	2.9(0.8)	3.0(0.6)	3.0(0.7)	3.0(0.6)	3.0(0.7)
Bachelor's Initial-term Major[b,c]					
HUM	10.1	69.6	77.7	64.7	1.2
HUMarts	4.1	29.4	74.3	1.8	0.5
STEM	13.0	3.1	2.0	3.8	82.4
Initial-term Bachelor's GPA[b]	2.7(1.0)	2.8(0.9)	2.9(0.9)	2.8(0.9)	2.6(1.0)
Final Outcomes					
Graduated Bachelor's Program[b,c]	54.1	60.8	57.9	62.6	46.5
Began Graduate Education[b,c]	10.5	10.3	4.9	13.7	7.1
1st Year Wage (thousands)[f]	24.0	18.7	16.6	20.0	24.2
3rd Year Wage (thousands)[f]	27.5	21.8	20.1	22.9	29.9

[a] Percentages are shown for dichotomous variables, and means with standard deviations in parentheses for continuous variables.
[b]CUNY data.
[c]NSC data.
[d]Values based on first associate-program term.
[e]Values based on all CUNY associate'program terms.
[f]Mean yearly wages after entering the workforce for years since last enrolling.

Further, wages for STEM bachelor's-degree recipients were higher than for HUM bachelor's recipients. Yet by the fourth year following enrollment, HUMnonarts bachelor's recipients had greater mean wages than STEM nongraduates.

Sankey Diagrams of Student Major Declaration Path Trends

The Sankey diagrams in this section show the majors declared at the three-time points identified above. Figure 2 shows the major declaration paths of students who declared majors in HUMnonarts or HUMarts (top panel) or STEM (bottom panel) immediately after transfer to a bachelor's program. Each panel groups students on the left according to their initial associate-program majors, and on the right according to their initial bachelor's-program majors. Line thickness represents the number of students that followed each major declaration path. Among students who began their bachelor's studies in a HUMnonarts major, the largest proportion originated in associate LAS majors (53.0%), with only 9.4% from HUMnonarts majors. However, for HUMarts bachelor's students, only 31.2% originated in associate LAS majors, with 29.3% from associate HUMarts majors. These numbers likely reflect the fact that CUNY bachelor's colleges offer HUMnonarts degree programs in a larger range of subjects (48 unique CIP values) than do CUNY community colleges (23 unique CIP values), with some CUNY community colleges offering no HUMnonarts degree programs. A majority (52.3%) of initial-term STEM bachelor's majors had studied STEM at the associate level, while 24.7% had studied LAS.

FIGURE 1
MEAN NYS YEARLY WAGES OF VERTICAL TRANSFER STUDENTS BY MAJOR AND BACHELOR'S DEGREE STATUS

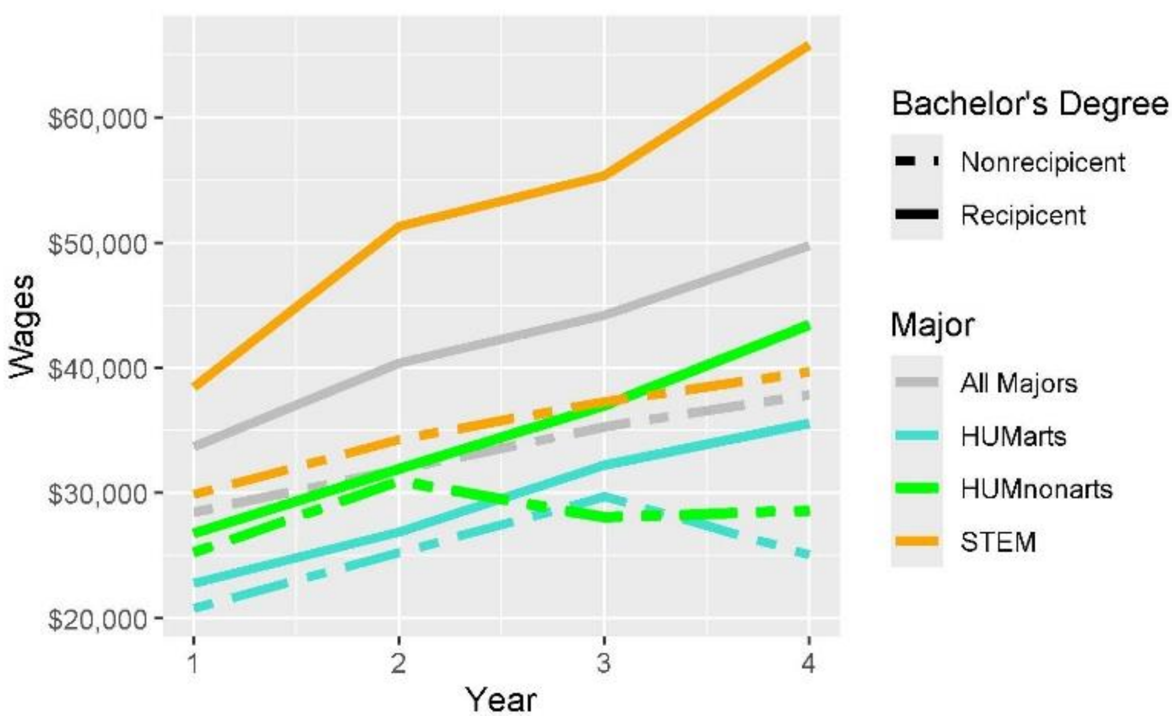

FIGURE 2
INITIAL ASSOCIATE AND BACHELOR'S PROGRAM MAJORS OF STUDENTS WHO INITIALLY DECLARED A HUMARTS, HUMNONARTS, OR LAS MAJOR (TOP PANEL) OR A STEM MAJOR (BOTTOM PANEL) UPON TRANSFER TO A BACHELOR'S PROGRAM

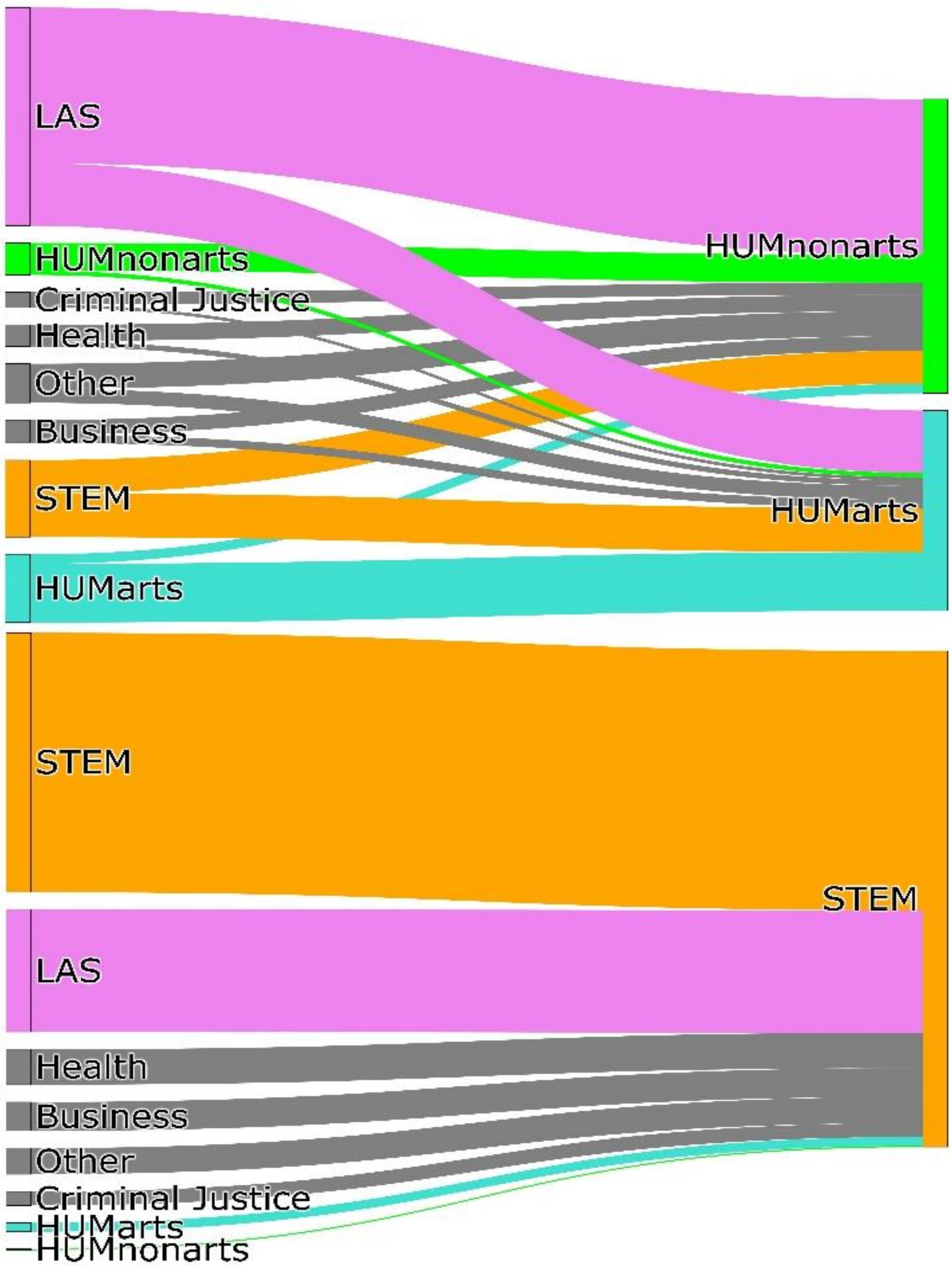

FIGURE 3
MAJOR DECLARATION TRAJECTORIES AMONG ALL STUDENTS WHOSE FINAL BACHELOR'S MAJOR WAS IN HUMARTS OR HUMNONARTS (TOP PANEL) OR A STEM MAJOR (BOTTOM PANEL), SHOWING INITIAL ASSOCIATE MAJOR, INITIAL BACHELOR'S MAJOR, AND FINAL BACHELOR'S MAJOR

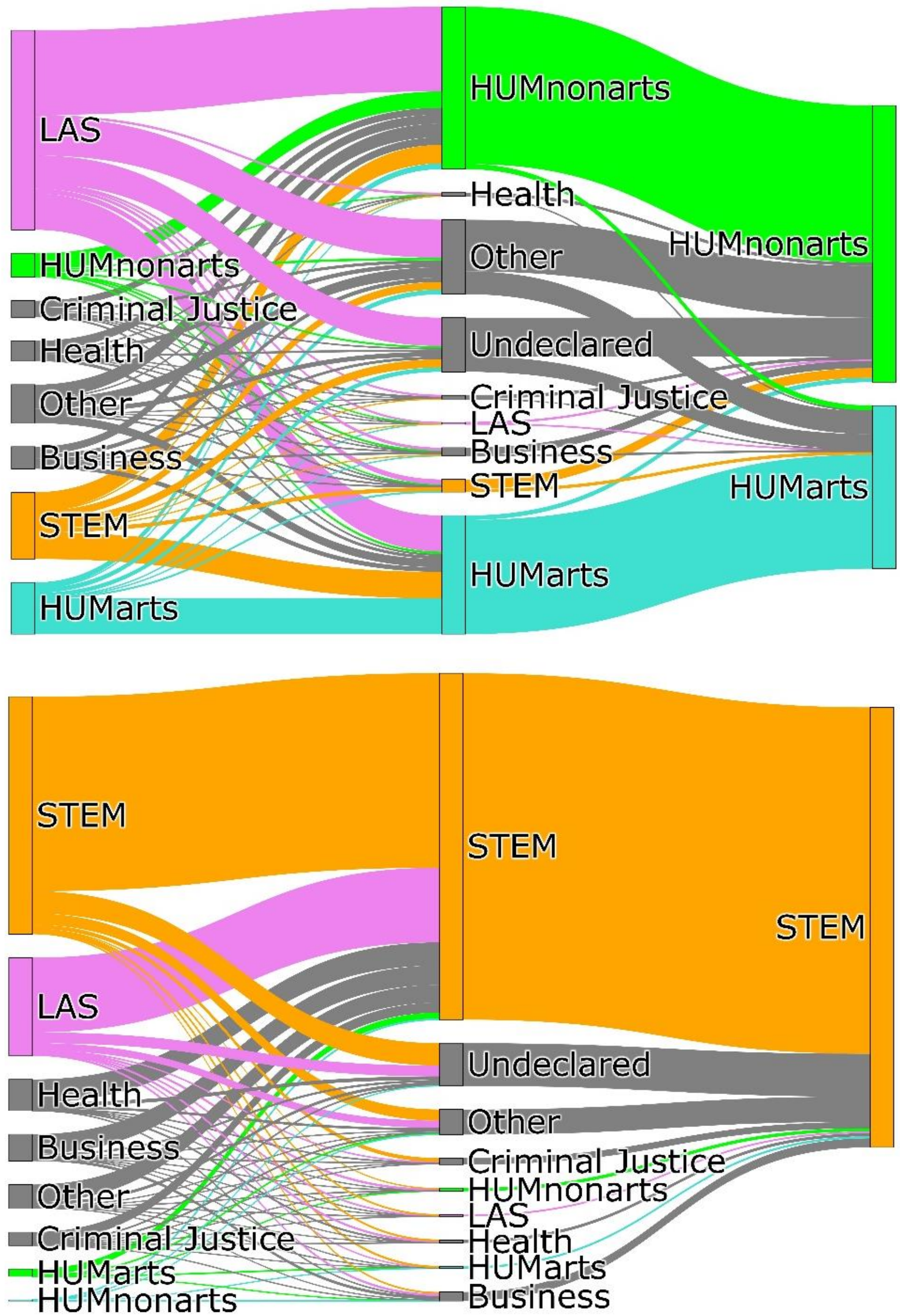

Figure 3 shows the major declaration paths of vertical transfer students whose final bachelor's majors were HUMarts, HUMnonarts (top panel), or STEM (bottom panel; each panel includes both majors of double-majoring students). The majority (82.2%) of students who had a HUM final bachelor's major did not major in HUM as associate-degree students. In addition, over a third (37.1%) of students who ultimately became a final bachelor's HUMnonarts major did so only after their first bachelor's-program term. Unlike HUM students, the majority (82.4%) of final STEM-major students had declared a STEM major upon transfer to a bachelor's program, and most (56.1% of) initial-term STEM bachelor's majors whose final major was STEM had studied STEM at the associate level.

Regression Models Evaluating Relationships Between Student Characteristics and Outcomes

Description of Models

We used regression models to evaluate the relationships between multiple student academic and demographic characteristics and each of the following separate outcomes y_m:

- Major declared upon entry to associate-degree program,
- Transfer to a bachelor's program,
- Major declared upon entry to a bachelor's-degree program,
- Final bachelor's program major at graduation or during most recent term enrolled,
- Graduation with bachelor's degree,
- Graduate study enrollment, and
- First-year and third-year wages following graduation or stop-out from enrollment.

Continuous outcome variables were modeled using multilevel generalized linear regression models (with no link function), while dichotomous outcome variables were modeled using multilevel generalized linear regression models with a logit link function. Such models adjust for institutional differences at each college each year, for example differences in college majors offered. For the outcomes of both the initial choice of associate-degree major and transfer-to-a-bachelor's-program, all students (N=92,169) were included in the analyses. The 38,394 students identified as having transferred to a bachelor's program were included for the outcomes involving a student's posttransfer bachelor's-level education. For first- and third-year wage outcomes, only students with yearly New York State wage data who had never enrolled in graduate-level studies were included, and analyses were conducted separately for bachelor's students who had graduated and those who had not. Equation 1 describes the multilevel model:

$$y_{ijk} = \alpha_0 + \hat{u}_k + u_{jk} + \beta X_{ijk} + \varepsilon_{ijk} \ . \qquad (1)$$

For continuous outcome variables, y was assumed to be distributed normally, whereas for dichotomous outcomes variables for which a logit link function was applied, y was assumed to have a binomial distribution, with $\hat{p}$ representing the probability that y=1. For each model, fixed effects β were fit to predictor or control variables $\boldsymbol{X}$ which varied only at the student level. The variables $\boldsymbol{X}$ used as predictors or control variables within each statistical model varied following the outcomes being evaluated, with the variables used being ones that described student characteristics at time points before or proximal to the outcome being examined (see Appendix 2).

Random effects for model-adjusted differences between the mean outcome value during year j at college k (α_{jk}) and the overall college k mean (α_k) were specified with u_{jk}. College random effects for model-adjusted differences between the intercept associated with the sample mean (α_0) and each college k mean (α_k) were specified with $\hat{u}_k$. For models examining only associate-degree student characteristics and outcomes, associate-degree students' program college and admission year defined random effects. For models whose samples were students who had transferred to bachelor's degree programs, bachelor's-degree institution and year of program entry defined random effects, while these students' associate-degree program, college, and admission year were included as fixed effects. For wage outcome models, most recent college and year of study (year of graduation or stop-out) defined random effects, with initial-term bachelor's college and year of entry to the bachelor's program as fixed effects. The error term ε_{ijk} was assumed distributed normally with mean zero.

Given that the LAS major was primarily available to students in associate, and not bachelor's, programs, the major declaration outcome variables differed for regressions conducted with data from different time points in the vertical transfer pipeline. In addition, because analyses included both students who had declared HUM majors and those who had declared STEM majors, a HUM dummy variable tested for differences between HUM students and STEM (referent category) students, and a HUMarts dummy variable tested for differences between HUMarts and HUMnonarts (referent category) students (See Appendix 3 for additional regression model specifications and outputs). Model coefficients (β) and standard errors (SE) were calculated for continuous outcome model fixed effects. Odds ratios (OR) and 95% confidence intervals (CI) were calculated for dichotomous outcome model fixed effects.

Initial Associate-Degree Major Declaration and Transfer to Bachelor's Programs

We first examined the associations between students' characteristics and the declaration of HUM (including HUMarts and HUMnonarts), LAS, and STEM associate-degree majors upon entry to an associate program (Table 3). In terms of significant associations involving demographic student characteristics, Black/African American students were more likely than White students to initially declare a HUMarts or STEM major. In contrast, Asian students were less likely to declare HUMnonarts majors but more likely to declare a STEM major. Students in all nonWhite race/ethnicity categories were less likely to declare a LAS major than White students. Male students were less likely to declare a HUM major but more likely to declare a STEM major. Older students were less likely to declare HUMarts, LAS, or STEM majors. However, there was no significant relationship between age and declaration of HUMnonarts majors.

Many significant relationships existed between students' initial associate majors and their academic and financial characteristics. Students who attended domestic high schools outside of the NYC public high school system were more likely to declare HUMnonarts majors, and students who attended nondomestic high schools were less likely to declare a LAS major but more likely to declare a STEM major. Further, students who were identified as needing math remediation were more likely to declare HUM majors (of any type) and less likely to declare STEM majors. In contrast, students who were identified as needing reading or writing remediation were less likely to declare a HUMnonarts major. Finally, PELL grant recipients were less likely to declare a HUM major, and students with higher family incomes were less likely to declare a HUMarts or STEM major.

As shown in Table 4, HUMnonarts majors were more likely than STEM majors to transfer to a bachelor's while HUMarts majors were less likely to transfer to a bachelor's program than STEM and HUMnonarts students. Black, Hispanic, and Asian students were less likely to transfer to bachelor's programs than White students. Male and older students were less likely to transfer to a bachelor's program than students who received initial-term PELL or who enrolled in AAS degree programs. Students assessed as needing remedial math or who were LAS associate majors assessed as needing remedial writing were less likely to transfer to bachelor's programs. Students with greater family income, a higher initial-term GPA, earning more credits in their first term, or receiving more total financial aid awards during terms enrolled in an associate program were more likely to transfer to a bachelor's program.

TABLE 3
STUDENT CHARACTERISTICS ASSOCIATED WITH INITIAL DECLARATION OF ASSOCIATE DEGREE HUM (INCLUDING HUMARTS AND HUMNONARTS), LAS, OR STEM MAJORS

Major Declared:	HUM	HUMarts	HUMnonarts	LAS	STEM
Fixed Effects	OR(95% CI)	OR(95% CI)	OR(95% CI)	OR(95% CI)	OR(95% CI)
Race/Ethnicity (ref=White)					
American Indian	0.50(0.25-1.01)	0.67(0.33-1.35)	0.00(0.00-100.00)	0.60(0.49-0.75)***	1.44(1.12-1.84)**
Asian	0.79(0.69-0.91)**	0.89(0.76-1.05)	0.55(0.40-0.75)***	0.73(0.69-0.77)***	1.15(1.07-1.23)***
Black	1.30(1.17-1.46)***	1.33(1.16-1.52)***	1.03(0.82-1.31)	0.71(0.67-0.74)***	1.17(1.10-1.24)***
Hispanic	1.08(0.97-1.21)	1.14(0.99-1.30)	0.84(0.67-1.06)	0.78(0.74-0.82)***	0.98(0.92-1.04)
Male	0.79(0.73-0.85)***	0.85(0.78-0.93)***	0.72(0.62-0.84)***	0.62(0.60-0.64)***	3.09(2.97-3.21)***
Age[a]	0.89(0.82-0.97)**	0.85(0.76-0.94)**	1.02(0.88-1.18)	0.94(0.91-0.97)***	0.89(0.86-0.93)***
Remedial Need[a]					
Math	1.21(1.10-1.33)***	1.14(1.02-1.28)*	1.37(1.13-1.67)**	1.28(1.23-1.33)***	0.59(0.57-0.62)***
Reading	0.82(0.74-0.92)***	0.93(0.83-1.05)	0.55(0.42-0.71)***	1.03(0.99-1.07)	0.83(0.79-0.88)***
Writing	0.87(0.78-0.96)**	0.99(0.88-1.11)	0.65(0.53-0.81)***	0.95(0.91-0.99)*	1.10(1.05-1.15)***
High School (ref=NYC DOE)					
Other HS	1.09(0.99-1.20)	0.96(0.83-1.10)	1.46(1.20-1.78)***	1.00(0.96-1.04)	1.02(0.96-1.08)
Nondomestic HS	0.89(0.71-1.11)	0.86(0.66-1.11)	1.04(0.73-1.50)	0.78(0.72-0.85)***	1.32(1.22-1.43)***
HS GPA	1.03(0.98-1.07)	0.98(0.93-1.04)	1.09(1.00-1.20)	1.04(1.02-1.06)***	1.08(1.05-1.10)***
PELL Recipient[a]	0.82(0.75-0.90)***	0.87(0.79-0.96)**	0.76(0.63-0.93)**	1.04(1.00-1.08)	0.98(0.93-1.02)
Total Family Income[a]	0.96(0.91-1.01)	0.94(0.90-0.98)*	0.99(0.87-1.13)	1.02(1.00-1.05)	0.97(0.95-1.00)*

Note: The modeling procedure used was equivalent to multilevel multinomial logistic regression. Column heads identify the major that corresponds to the model's outcome variable. *p<.05, **p<.01, ***p<.001.
[a]Variable values reflect characteristics at the time of a student's entry to their first associate degree program.

TABLE 4
STUDENT CHARACTERISTICS ASSOCIATED WITH TRANSFER TO A BACHELOR'S PROGRAM

	Transferred to Bachelor's Program
Fixed Effects	OR(95% Conf Int)
Race/Ethnicity (ref=White)	
American Indian	0.87(0.69-1.10)
Asian	0.91(0.86-0.97)**
Black	0.74(0.70-0.78)***
Hispanic	0.65(0.61-0.68)***
Male	0.59(0.57-0.61)***
Age[a]	0.73(0.71-0.75)***
Total Family Income[a]	1.16(1.14-1.19)***
Remedial Need[a]	
Math	0.68(0.65-0.70)***
Reading	0.98(0.93-1.02)
Writing	0.96(0.92-1.00)
AAS Degree Program[a]	0.76(0.72-0.79)***
PELL Recipient[a]	0.52(0.48-0.55)***
Associate Major[a] (ref=STEM)	
HUM	1.17(1.01-1.36)*
HUMarts[b]	0.61(0.52-0.73)***
LAS	0.94(0.89-0.98)**
Total Grant Award	1.67(1.62-1.72)***
Terms in Associate	1.23(1.20-1.26)***
Proportion Terms Received Grants	1.12(1.09-1.16)***
Initial-term Credits Passed[a]	1.57(1.53-1.61)***
Initial-term GPA[a]	1.64(1.60-1.68)***

Note: Column heads identify the major that corresponds to the model's outcome variable. *p<.05, **p<.01, ***p<.001.
[a]Variable values reflect characteristics at the time of a student's entry to their first associate-degree program.
[b]The HUM dummy variable applies to all HUM students (HUMarts and HUMnonarts), with STEM as the referent category; the HUMarts dummy variable additionally applies to the subset of HUMarts students, with HUMnonarts as the referent category.

Initial and Final Bachelor's Major Declaration

Numerous student characteristics were significantly associated with bachelor's students' initial declaration of a HUM or STEM major (Table 5). For example, Black and Hispanic students were more likely to declare a bachelor's HUMnonarts major, but not a HUMarts major, in comparison to White students. However, Asian students were less likely to declare bachelor's HUMnonarts majors than White students. Male students and students assessed as needing math remediation were more likely to declare HUM majors, and students assessed as needing remedial reading or writing were less likely. Assessed remedial need in writing was positively associated with declaring a STEM major. Regarding academic performance variables, students who had declared a HUM major in their associate program were more likely than STEM associate majors to declare a HUM major upon transfer to a bachelor's program. LAS associate majors were more likely than STEM majors to declare HUMnonarts majors. Students who had been seeking AAS degrees in the first term of their associate programs were more likely to declare bachelor's HUM or STEM majors than were nonAAS students. Finally, having more credits at transfer was associated with declaring HUM and STEM bachelor's majors, while greater GPA was associated with declaring a HUMarts major.

Table 5 also shows results for the outcome of declaration of a final (or most recent) HUM or STEM major among students who transferred to bachelor's programs. Hispanic students were more likely to declare HUM majors than White students, male students were more likely to declare HUMarts or STEM majors than female students, and age was negatively associated with declaring a HUM major but positively associated with declaring a STEM major. Students who initially declared AAS majors were likelier to declare a final HUMarts major. Declaring an initial associate HUM major was positively associated with declaring a final bachelor's HUM major.

Bachelor's Graduation and Graduate Study

Table 6 shows numerous significant associations of student characteristics with bachelor's graduation and beginning graduate study by summer 2022, for students who had transferred to bachelor's programs. Focusing on academic characteristics, initial associate HUM majors were more likely than initial STEM associate majors to have begun a graduate program, and initial HUMarts associate majors transfer students were less likely than initial STEM associate majors transfer students to graduate with a bachelor's degree. Final HUM bachelor's majors were more likely to graduate than final STEM bachelor's majors. A similar pattern held concerning beginning graduate school: Final HUMnonarts (but not final HUMarts) bachelor's majors were likelier to begin graduate studies than final STEM bachelor's majors.

There were 485 final HUM bachelor's majors and 346 former final STEM bachelor's majors who had begun graduate school as of 2022. These students' characteristics were similar, with the following exceptions. First, a smaller proportion of graduate enrollees who had been HUM as opposed to STEM majors were Asian (15% vs. 37%), a larger proportion were Hispanic (42% vs. 21%), and a smaller proportion were male (27% vs. 54%). In addition, the mean family income when the students began their associate degrees was higher for the former HUM majors than for the former STEM majors (a mean of $41,000 vs. $28,000). Further, the graduate enrollees who were former HUM bachelor's majors had been assessed as needing remediation for math at a greater rate than was the case for graduate enrollees who were former STEM bachelor's majors (62% vs 29%), but the opposite was true for writing (16% vs. 31%).

TABLE 5
STUDENT CHARACTERISTICS ASSOCIATED WITH INITIAL AND FINAL DECLARATION OF BACHELOR'S-DEGREE HUM (INCLUDING HUMARTS AND HUMNONARTS), OR STEM MAJORS AMONG STUDENTS WHO TRANSFERRED TO BACHELOR'S PROGRAMS

Initial Bachelor's Major Declared:	HUM	HUMarts	HUMnonarts	STEM
Fixed Effects	OR(95% CI)	OR(95% CI)	OR(95% CI)	OR(95% CI)
Race/Ethnicity (ref=White)				
American Indian	0.97(0.53-1.78)	1.42(0.58-3.46)	0.67(0.29-1.55)	1.18(0.70-2.01)
Asian	0.80(0.70-0.92)**	1.00(0.81-1.23)	0.68(0.56-0.81)***	1.54(1.37-1.73)***
Black	1.13(1.00-1.28)*	1.07(0.89-1.29)	1.18(1.01-1.37)*	1.03(0.91-1.16)
Hispanic	1.18(1.05-1.33)**	1.05(0.87-1.26)	1.24(1.08-1.43)**	0.93(0.83-1.04)
Male	1.24(1.15-1.34)***	1.41(1.25-1.59)***	1.09(0.99-1.21)	2.45(2.27-2.64)***
Age[a]	0.95(0.88-1.02)	0.96(0.85-1.09)	0.95(0.87-1.05)	1.03(0.96-1.11)
Total Family Income[a]	0.99(0.95-1.03)	1.02(0.94-1.12)	0.97(0.92-1.02)	0.97(0.93-1.01)
Remedial Need[a]				
Math	1.41(1.29-1.54)***	1.31(1.14-1.50)***	1.45(1.30-1.62)***	0.58(0.53-0.62)***
Reading	0.83(0.73-0.94)**	0.82(0.67-0.99)*	0.86(0.73-1.00)	1.01(0.90-1.12)
Writing	0.86(0.76-0.96)**	1.05(0.89-1.23)	0.74(0.64-0.86)***	1.36(1.23-1.51)***
AAS Degree Program[a]	1.70(1.50-1.92)***	1.69(1.43-1.99)***	1.51(1.28-1.79)***	1.15(1.04-1.27)**
Associate Major[a] (ref=STEM)				
HUM	8.17(6.64-10.07)***	1.28(0.86-1.89)	14.1(11.13-17.88)***	0.06(0.03-0.11)***
HUMarts[b]	1.42(1.13-1.78)**	13.51(9.06-20.14)***	0.11(0.08-0.15)***	2.68(1.44-5.00)***
LAS	1.62(1.45-1.82)***	0.92(0.78-1.10)	2.37(2.03-2.77)***	0.20(0.18-0.22)***
Total Credits at Transfer	1.18(1.12-1.24)***	1.15(1.07-1.24)***	1.18(1.11-1.27)***	1.27(1.21-1.32)***
GPA at Transfer	1.09(1.03-1.15)**	1.11(1.03-1.20)**	1.05(0.98-1.13)	0.96(0.92-1.01)

Final Bachelor's Major Declared:	HUM	HUMarts	HUMnonarts	STEM
Fixed Effects	OR(95% CI)	OR(95% CI)	OR(95% CI)	OR(95% CI)
Race/Ethnicity (ref=White)				
American Indian	0.85(0.37-1.96)	0.68(0.18-2.56)	1.01(0.41-2.46)	1.52(0.74-3.11)
Asian	0.97(0.82-1.16)	1.22(0.91-1.64)	0.84(0.69-1.03)	1.44(1.22-1.71)***
Black	1.08(0.92-1.27)	1.04(0.78-1.38)	1.09(0.91-1.31)	0.91(0.77-1.08)
Hispanic	1.18(1.01-1.37)*	1.11(0.86-1.44)	1.18(1.00-1.39)	0.92(0.78-1.09)
Male	1.08(0.97-1.20)	1.29(1.08-1.54)**	0.99(0.88-1.12)	1.95(1.75-2.17)***
Age[a]	0.90(0.81-1.00)*	0.99(0.83-1.18)	0.87(0.78-0.98)*	1.28(1.15-1.42)***
Total Family Income[a]	0.97(0.92-1.03)	0.97(0.87-1.09)	0.98(0.92-1.04)	1.00(0.94-1.08)
Remedial Need[a]				
Math	1.15(1.03-1.30)*	0.87(0.72-1.05)	1.27(1.11-1.45)***	0.58(0.52-0.65)***
Reading	0.91(0.78-1.08)	1.01(0.76-1.34)	0.89(0.74-1.07)	1.03(0.88-1.21)
Writing	0.93(0.79-1.08)	1.12(0.88-1.42)	0.84(0.70-1.01)	1.23(1.07-1.42)**
Associate Major[a] (ref=STEM)				
HUM	3.49(2.48-4.92)***	0.74(0.39-1.42)	4.23(2.98-6.01)***	0.19(0.10-0.38)***
HUMarts[b]	1.35(0.92-2.00)	9.15(4.66-17.97)***	0.32(0.20-0.50)***	1.70(0.79-3.65)
LAS	1.45(1.24-1.68)***	1.13(0.88-1.45)	1.56(1.31-1.86)***	0.28(0.24-0.32)***
AAS Degree Program$_a$	1.32(1.12-1.55)***	1.56(1.22-2.00)***	1.10(0.91-1.33)	1.07(0.92-1.24)
Total Credits at Transfer	0.96(0.89-1.02)	0.96(0.86-1.07)	0.98(0.90-1.06)	1.11(1.04-1.18)***
GPA at Transfer	1.04(0.97-1.11)	1.05(0.93-1.18)	1.05(0.96-1.14)	1.07(0.99-1.16)
Initial Bachelor's Major[c] (ref=STEM)				
HUM	136.34(113.49-163.80)***	2.95(2.12-4.10)***	132.38(109.75-159.67)***	0.01(0.01-0.01)***
HUMarts[b]	1.81(1.42-2.31)***	236.00(169.57-328.47)***	0.01(0.01-0.01)***	0.50(0.29-0.89)*

Note: Bachelor's majors were not mutually exclusive. *p<.05, **p<.01, ***p<.001.

aVariable values reflect characteristics at the time of a student's entry to their first associate degree program.

bThe HUM dummy variable applies to all HUM students (HUMarts and HUMnonarts); the HUMarts dummy variable additionally applies to the subset of HUMarts students.

TABLE 6
STUDENT CHARACTERISTICS ASSOCIATED WITH BACHELOR'S GRADUATION AND ENROLLMENT IN GRADUATE STUDY AMONG STUDENTS WHO TRANSFERRED TO BACHELOR'S PROGRAMS

	Graduation with Bachelor's Degree	Enrollment in Graduate Study
Fixed Effects	OR(95% CI)	OR(95% CI)
Race/Ethnicity (ref=White)		
American Indian	1.20(0.82-1.75)	0.96(0.58-1.59)
Asian	1.12(1.03-1.23)**	0.77(0.68-0.86)***
Black	0.80(0.73-0.87)***	0.72(0.64-0.80)***
Hispanic	0.70(0.65-0.76)***	0.63(0.56-0.70)***
Male	0.68(0.65-0.72)***	0.63(0.58-0.68)***
Age[a]	0.85(0.81-0.89)***	0.95(0.89-1.02)
Total Family Income[a]	1.07(1.03-1.11)**	1.03(0.98-1.09)
Remedial Need[a]		
Math	0.97(0.91-1.02)	0.89(0.82-0.97)**
Reading	1.09(1.01-1.18)*	0.93(0.81-1.06)
Writing	1.05(0.98-1.13)	0.93(0.83-1.05)
AAS Degree Program[a]	0.87(0.81-0.94)***	0.83(0.74-0.93)**
Associate Major[a] (ref=STEM)		
HUM	1.19(0.95-1.49)	1.42(1.09-1.86)*
HUMarts[b]	0.64(0.49-0.84)**	0.56(0.39-0.80)**
LAS	0.96(0.89-1.04)	1.05(0.94-1.18)
Total Credits at Transfer	1.42(1.37-1.48)***	0.94(0.90-0.98)**
GPA at Transfer	1.83(1.76-1.90)***	2.25(2.12-2.38)***
Final Bachelor's Major[c] (ref=STEM)		
HUM	1.46(1.30-1.63)***	1.38(1.20-1.60)***
HUMarts[b]	0.89(0.77-1.02)	0.37(0.29-0.48)***

Note: Column heads describe the model's outcome variable. *p<.05, **p<.01, ***p<.001.
aVariable values reflect characteristics at the time of a student's entry to their first associate degree program.
bThe HUM dummy variable applies to all HUM students (HUMarts and HUMnonarts); the HUMarts dummy variable additionally applies to the subset of HUMarts students.

Wages After Graduation or Since Most Recent Term Enrolled

Sample members were included in these analyses if they had transferred to a bachelor's program, had been employed in New York State each year since their last enrollment, and had not begun graduate school (total n=27,431). Table 7 shows associations between student characteristics and academic performance with yearly wages for bachelor's-degree recipients and nonrecipients, both one and three years following students' final year of higher education enrollment (students who entered graduate study were excluded from these analyses). Regarding academic performance, for bachelor's-degree recipients, having declared HUM as a final major was associated with lower wages than having declared STEM as a final major. Former HUMarts majors had lower first-year wages than former HUMnonarts majors for bachelor's-degree recipients, however, this difference disappeared by the third-year's wages. Final GPA was positively associated with differences in expected wages in the first year following enrollment for bachelor's-degree recipients and at years one and three for degree nonrecipients.

TABLE 7
STUDENT CHARACTERISTICS ASSOCIATED WITH VERTICAL TRANSFER STUDENTS 1ST AND 3RD YEAR NEW YORK STATE WAGES FOLLOWING BACHELOR'S GRADUATION OR STOP OUT AMONG STUDENTS WHO TRANSFERRED TO BACHELOR'S PROGRAMS

	Received Bachelor's Degree		Did not Receive Bachelor's Degree	
	Year 1 Wages	Year 3 Wages	Year 1 Wages	Year 3 Wages
Fixed Effects	β(SE)	β(SE)	β(SE)	β(SE)
Race/Ethnicity (ref=White)				
American Indian	-4.05(2.88)	0.57(4.88)	0.01(3.26)	2.65(5.30)
Asian	-2.15(0.69)**	-2.46(1.02)*	-2.45(0.82)**	-6.14(1.34)***
Black	-1.78(0.67)**	-3.3(1.02)**	-2.65(0.69)***	-4.94(1.13)***
Hispanic	-0.51(0.64)	-2.64(0.95)**	-1.28(0.67)	-3.97(1.09)***
Male	0.83(0.43)	2.20(0.64)***	3.00(0.42)***	3.08(0.70)***
Age[a]	2.62(0.45)***	1.49(0.72)*	3.16(0.42)***	2.54(0.70)***
Total Family Income[a]	0.19(0.24)	0.19(0.35)	0.34(0.22)	0.78(0.34)
Remedial Need[a]				
Math	-1.47(0.48)**	-1.84(0.72)*	-1.80(0.47)***	-0.19(0.81)
Reading	-1.27(0.63)*	-0.77(1.06)	-0.75(0.64)	-1.70(1.06)
Writing	-1.27(0.60)*	0.53(0.97)	-1.18(0.58)*	0.35(1.00)
AAS Degree Program[a]	0.45(0.63)	-0.07(0.96)	0.44(0.60)	0.54(1.01)
Associate Major[a] (ref=STEM)				
HUM	-0.62(1.71)	-1.52(2.59)	-0.63(1.87)	-3.78(3.46)
HUMarts[b]	-1.03(2.09)	-6.69(3.14)*	-2.64(2.18)	0.50(3.88)
LAS	0.23(0.66)	-2.61(1.05)*	0.21(0.64)	0.49(1.13)
Received Associate Degree	-1.33(0.49)**	-1.22(0.74)	0.33(0.47)	0.14(0.80)
Final Bachelor's Major (ref=STEM)				
HUM	-5.21(0.93)***	-8.5(1.45)***	-2.34(0.96)*	-3.75(1.78)*
HUMarts[b]	-3.06(1.13)**	-3.06(1.70)	-2.37(1.29)	0.70(2.23)
Final Total Credits	0.86(0.69)	1.33(1.14)	-0.17(0.34)	-0.24(0.57)
Final GPA	1.43(0.40)***	1.23(0.73)	0.88(0.22)***	1.12(0.35)**

Note: Students who began graduate-level education were excluded. Total N=27,431.
aVariable values reflect characteristics at the time of a student's entry to their first associate degree program.
bThe HUM dummy variable applies to all HUM students (HUMarts and HUMnonarts); the HUMarts dummy variable applies to the subset of HUMarts students.

DISCUSSION

The results reported here represent the first longitudinal, comprehensive, quantitative study of college students with majors in HUM or STEM regarding their vertical transfer, academic progress, and success, from the associate level to graduate study and wages. Perhaps the most surprising result was that, in comparison with STEM majors, students with HUM-related majors showed greater success on multiple academic measures, including vertical transfer success (Research Question 3). The supposition that HUM disciplines facilitate accumulation of general academic capital while STEM disciplines facilitate STEM-specific capital development may help explain this result (Bourdieu, 2005).

Overall, by tracking the academic progress of 92,169 students in CUNY's seven community colleges for 6-10 years, this study was able to identify multiple student characteristics associated with declaring a HUM or STEM associate and/or bachelor's major, vertical transfer, and bachelor's graduation, along with postgraduate outcomes (Research Questions 2 and 4). For example, contrary to the national data indicating HUM disciplines are dominated by White students (National Center for Education Statistics, 2018), in this sample Black and Hispanic students were significantly more likely than White students to declare a HUMnonarts major in their first semester in a bachelor's program (though the White subsample was relatively small). As another example, in comparison to HUM bachelor's graduates, STEM bachelor's graduates were more likely to pursue a STEM focus throughout their academic careers, but HUM graduates were more likely to have begun college in a variety of fields. This may be because success in STEM subjects may be particularly contingent on a form of STEM or subject-specific capital, creating greater path dependency in STEM pipelines (Archer et al., 2015).

Regarding initial major declaration, results indicated that, in this sample, relatively few students declared an associate HUM major, and most students who did studied fine or performing arts (Research Question 1). However, a large proportion declared LAS as their associate major. This may have occurred because some CUNY community colleges do not offer HUMnonarts majors, leaving LAS the most similar major option.

Turning in more detail to Research Question 2 (identification of student characteristics associated with HUM and STEM major declaration across the pipeline), students with remedial need in math were more likely to select HUM or LAS associate majors. At the same time, PELL grant recipients were less likely to select HUM associate majors. Students who had attended nondomestic high schools, and racial and ethnic minority students, were found to be less likely to select the LAS associate major and more likely (except for Hispanic students) to select a STEM associate major. STEM-specific courses' links to STEM-specific careers, providing access to greater economic capital, may help explain some of these associations (Sikora & Pokropek, 2021).

Regarding student outcomes concerning transfer (Research Questions 3 and 4), consistent with other findings, students facing economic disadvantage and underrepresented racial and ethnic minorities were less likely to transfer to bachelor's programs (Velasco et al., 2024). Further, having majored in HUM or LAS at the associate level was predictive of declaring an initial HUM bachelor's major, and having declared an initial HUM or STEM bachelor's major was predictive of whether a student declared HUM or STEM as their final major.

Also concerning Research Question 4, additional disparities in academic success outcomes were found in the pipeline outcomes associated with student demographic characteristics. Students with higher family incomes were likelier to graduate or begin graduate student enrollment, while male students were less likely. Asian students were more likely to graduate with a bachelor's degree than White students, and both Asian and White students were more likely to graduate than Black or Hispanic students. Asian, Black, and Hispanic students were less likely to enroll in graduate programs than White students. By the end of the pipeline to a bachelor's degree, at the beginning of graduate study, 21% of former HUM majors were Black and 42% were Hispanic, compared with 33% and 43% of HUM majors at the start. Among former STEM majors at the beginning of graduate study, 21% were Black and 21% were Hispanic, compared to 28% and 41% of STEM majors at the start of the pipeline. These percentages demonstrate that Black and Hispanic students (other than Hispanic HUM students) were more likely to leak out of the pipeline. Nevertheless, among former HUM and former STEM majors, the percentages of students who began graduate study who were either Black or Hispanic (HUM: 63%, STEM: 42%), are more than four times greater than the 10% total of current faculty who are Black or Hispanic (National Center for Education Statistics, 2018). Thus, the sample and pipeline described here exemplify a viable source for future faculty from underrepresented groups.

Finally, we examined the results comparing the transfer success of HUM and STEM students (Research Questions 3 and 4). HUMnonarts students were likelier to transfer to bachelor's programs, graduate, and begin graduate study than STEM students. Beyond the previously discussed theoretical viewpoint positing greater alignment between HUM disciplines with development of general academic capital, and STEM disciplines with development of subject-specific capital, reasons for an academic advantage of HUMnonarts over STEM may be that STEM students may face STEM-specific academic challenges, including difficult-to-navigate sequenced STEM curriculum requirements, STEM courses with lower completion and pass rates, and biases regarding STEM professionals' assumed sociodemographics (which often do not include the underrepresented minorities and women widely present within community college cohorts; Park & Ngo, 2021; Santiago et al., 2022). HUM major coursework, in contrast, may have fewer prerequisites, fewer required course sequences, and offer more options in fulfilling major requirements (Lichtenstein et al., 2010). However, note that, in the current study, student success outcomes also differed between HUMnonarts and HUMarts students, with HUMarts students being relatively less likely to transfer, graduate with a bachelor's degree, or begin graduate study. A potential explanation might be unique additional HUMarts academic requirements such as challenging auditions and/or recitals. HUMarts programs may also emphasize the development of subject-specific capital (e.g., knowledge of painting techniques) more than HUMnonarts programs (Hetland & Winner, 2001). These differing emphases may provide HUMarts students with relatively less generalized academic capital beneficial to higher education success in other subjects and contexts.

Limitations of this study include that, although the sample used was large, it may not be representative of students at some other colleges. Specifically, the sample's large proportion of Black and Hispanic students (72.2%), and small proportion of White students (13%), differ from the proportions for the United States undergraduate population as a whole (31.9% and 51.6%, respectively). Further, in the current sample, a greater proportion of students received Pell grants (72.8%) than the national percentage (44%; National Center for Education Statistics, 2018). In addition, within the current sample, the total number of HUM students at each key point during the undergraduate timeline (between 3,663 and 4,709), was a small proportion of the HUM students in the United States. The inclusion of five complete yearly cohorts from seven community colleges, totaling over 90,000 students, may meliorate that limitation. Finally, another limitation is that, due to the study employing correlational data, identifying significant relationships does not definitively tell us the mechanism by which particular student characteristics are associated with particular outcomes.

CONCLUSION

Implications for Practice and Future Research

The results suggest several concrete actions for increasing students in the HUM and STEM vertical transfer pipelines, and thus increasing HUM and STEM student and faculty diversity. First, for HUM, given that HUM bachelor's graduates tended to come from many different fields, and those Black and Hispanic students were significantly more likely in this sample to become HUMnonarts majors in comparison to White students, recruitment for HUM bachelor's majors from many different associate-degree fields, as well as recruitment for HUMnonarts majors in Black and Hispanic populations, may be productive. Additional actions that can be taken are to develop additional HUM programs at the associate level and inform new and ongoing community college students about HUM majors, graduate study, and employment opportunities (see Bickerstaff et al., 2023, for similar suggestions). Supporting these recommendations is that, compared to STEM majors, the output of the HUM vertical transfer pipeline (particularly as it relates to HUMnonarts students) was limited by its input as opposed to loss along the pipeline. HUMnonarts students were less likely to be lost along the pipeline than were STEM students, but students were less likely to choose HUM-related paths at the beginning of community college than STEM-related paths. Given that LAS majors serve as a fertile ground for selection of HUM bachelor's majors, encouraging more underrepresented minority students to pursue LAS majors while they prepare for vertical transfer could be one useful strategy. Similarly, having majors more directly related to specific HUM disciplines at the associate level might encourage even more students to major in HUM. However, there are not yet any data to support such an approach, including regarding the long-term benefits to students, up to and following bachelor's receipt.

No matter which HUM majors are offered, incoming, and continuing, students' perceptions of HUM may not be particularly favorable given these majors' association with lower earnings (Carnevale & Cheah, 2018). Therefore, instead of referencing the more abstract concepts of cultural and academic capital, giving students more information about the relatively positive outcomes for HUM majors may increase enrollment in a variety of HUM-related majors paths. The HUM pipeline may benefit from students (and their parents) learning that, though HUM majors may not lead to as high an immediate wage return, HUMnonarts education provides greater odds of graduation (important for higher wages and career success), as well as a greater likelihood of graduate study. Community college students would also be well served by being informed of HUM disciplines' direct relevance to a large variety of careers and to long-term professional success. Future research could assess the effect of the delivery of such information on both initial and later HUM enrollment and major declaration.

The actions that would help increase students and faculty in STEM, and their diversity, appear to be different than those for HUMnonarts. We found STEM disciplines to face relatively more retention and degree completion challenges than challenges associated with the size of the incoming community college cohort. Therefore, in the case of STEM, our results suggest that providing support to students who declare STEM majors, and providing that support throughout their college careers, may be most important for increasing graduation in STEM fields. Examples of such programs include the National Science Foundation's program "Advancing Innovation and Impact in Undergraduate STEM Education at Two-Year Institutions of Higher Education" (https://bit.ly/43EUJn0).

Ultimately, enhanced early exposure to HUM majors and careers and better representation of HUM fields' opportunities for success may be instrumental in expanding the HUM pipeline to include more community college students, along with the diverse array of backgrounds, perspectives, and experiences that these students bring. STEM fields, in contrast, would benefit from retention-focused programs, particularly programs aimed toward supporting students from underrepresented minority groups. Considering HUM's and STEM's roles in generating a critical thinking and problem-solving population able to bridge differences and identify solutions through communication and deliberation, ensuring that both HUM and STEM disciplines continue to have robust, diverse pipelines remains vital.

ACKNOWLEDGEMENTS

Portions of this research were presented at the National Institute for the Study of Transfer Students 2023 Annual Conference. We have no known conflicts of interest to disclose. This study was funded by the Mellon Foundation, The City University of New York, and by Grant R305A180139–19 from the Institute of Education Sciences (IES) of the Department of Education (the contents of this paper do not necessarily represent the policy of the Department of Education, and endorsement by the Federal Government should not be assumed). For contributions to all stages of the research, including comments on previous drafts, we thank many members of CUNY's Office of Applied Research, Evaluation, and Data Analytics, led by Senior University Dean Chellman, particularly K. Gentsch, Y. Oka, S. Sheets, R. Torres, and N. Yoo, and the many members of CUNY's Transfer Opportunity Project.

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APPENDIX 1: ASSOCIATE-DEGREE PROGRAMS MAJOR CATEGORIES, CIP CODES, AND STUDENT COUNTS

Major Category	2-digit CIP codes	Students[a]	CIP Program Content
Humanities	05	0	Area, Ethnic, Cultural, and Gender Studies
	09	593	Communication, Journalism, and Related Programs
	16	22	Foreign Languages, Literatures, and Linguistics
	23	392	English Language and Literature/Letters
	38	23	Philosophy and Religious Studies
	50[b]	2,897	Visual and Performing Arts
	54	26	History
	24.0103[c]	0	Humanities/Humanistic Studies
LAS	24.0101[c]	31,530	LAS/Liberal Studies
STEM	10	1,726	Communications Technologies/Technicians and Support Services
	11	4,215	Computer and Information Sciences and Support Services
	14	2,109	Engineering
	15	1,239	Engineering Technologies/Technicians
	26	1,209	Biological and Biomedical Sciences
	27	254	Mathematics and Statistics
	40	3,798	Physical Sciences
	41	0	Science Technologies/Technicians
	47	703	Mechanic and Repair Technologies/Technicians
	43.0106[c]	1,079	Forensic Science and Technology

Major Category	2-digit CIP codes	Students[a]	CIP Program Content
Business	52	10,523	Business, Management, Marketing and Related Support Services
Health	51	9,804	Health Professions and Related Clinical Sciences
Criminal Justice[d]	43	10,444	Security and Protective Services
Undeclared[e]	24.0102[c]	607	General Studies
Other	All others	8,976	All others

[a]The number of students who began their associate degree in each listed CIP category.
[b]This CIP code was used to categorize Humanities students who were studying the Visual or Performing Arts.
[c]These six-digit CIP codes were used to identify major categories (instead of two-digit codes).
[d]CIP code 43's count excludes CIP 43.0106 students because 43.0106 (Forensic and Technology) was categorized as STEM.
[e]For initial community college major classification, the 607 24.0102 CIP code students (less than 1% of the sample) were included in the 'Other' major category

APPENDIX 2: ADDITIONAL STATISTICAL MODEL METHODOLOGICAL DESCRIPTION

Variables (X) used as predictors or control variables within the statistical models varied by the outcomes being evaluated, with the particular ones used describing characteristics at time points before or proximal to the outcome being examined. E.g., only for the statistical models that evaluated associations with initial associate major selection and with transfer to bachelor's programs were high school GPA and high school type included. For outcomes related to academic performance immediately following bachelor's transfer, initial-term associate GPA and credits earned were included, whereas for models for bachelor's graduation, cumulative GPA, and cumulative credits at the time of transfer were included instead. Financial aid variables describing aid received during associate-program enrollment were included in models examining transfer to a bachelor's program and initial bachelor's program. Wage models included a variable for receipt of an associate degree as a predictor. All models included as fixed effects the student demographic variables of age, gender, race/ethnicity, initial family income, remedial education by subject, and whether a student was initially in an Associate of Applied Science (AAS) degree program (at CUNY and elsewhere, AAS coursework is less likely to transfer to bachelor's degree programs than AA or AS coursework). When models included fixed effects for students' prior major, the STEM major served as referent. Each large nonSTEM major category (HUM, LAS, Business, Criminal Justice, Health, Other, and Undeclared) were controlled for using a dummy variable.

Multiple imputation for missing values among included variables was implemented using the R package 'mice' (van Buuren & Groothuis-Oudshoorn, 2011). Dichotomous variables were modeled and imputed using logistic regression, and continuous variables were modeled with predictive mean matching within a multiple imputation by chained equations framework with student characteristics serving as predictors.

APPENDIX 3: REGRESSION MODEL ADDITIONAL SPECIFICATIONS AND OUTPUTS

Table	Column	Outcome	Outcome Major	Additional Covariates	Students Included	N	Constant[a]	R^2 FE	Model R^2
3	1	Associate Initial Major Declared	HUM	Age^2	All Associate at 4 Colleges Offering HUM Majors	75,966	0.05	0.03	0.06
3	2	‖	HUMarts	‖	All Associate at 4 Colleges Offering HUMarts Majors	75,966	0.03	0.02	0.09
3	3	‖	HUMnonarts	‖	All Associate at 2 Colleges Offering HUMnonarts Majors	46,918	0.02	0.22	0.23
3	4	‖	LAS	‖	All Associate	92,169	0.43	0.03	0.12
3	5	‖	STEM	‖	‖	92,169	0.12	0.11	0.15
4	1	Transfer to Bachelor's Degree Program		Age^2, Dummy Variables for Additional Majors[b].	‖	92,169	0.72	0.37	0.38
5	1	Bachelor's Initial Major Declared	HUM	Age^2, Dummy Variables for: Additional Majors[b], Transferred to nonCUNY, Year Entered Associate Program, First Associate College	All Bachelor's Transfers	38,394	0.03	0.13	0.26

5	2	‖	HUMarts	‖	‖	38,394	0.01	0.08	0.53
5	3	‖	HUMnonarts	‖	‖	38,394	0.02	0.11	0.30
5	4	‖	STEM	‖	‖	38,394	0.31	0.23	0.37
5	1	Last-term Bachelor's Major Declared	HUM	Age^2, Dummy Variables for: Additional Majors[b], Transferred to nonCUNY, Year Entered Associate Program, First Associate College	‖	38,394	0.02	0.48	0.55
5	2	‖	HUMarts	‖	‖	38,394	0.00	0.38	0.62
5	3	‖	HUMnonarts	‖	‖	38,394	0.01	0.33	0.48
5	4	‖	STEM	‖	‖	38,394	0.92	0.57	0.63
6	1	Graduation with Bachelor's		Age^2, Dummy Variables for: Additional Majors[b], Transferred to nonCUNY, Year Entered Associate Program, First Associate College	‖	38,394	0.38	0.15	0.67
6	2	Enrolled in Graduate Study		‖	‖	38,394	0.16	0.26	0.33
7	1	First Year Wages		Age^2, Dummy Variables for: Additional Majors[b], Transferred to nonCUNY, Graduated From	Bachelor's Recipients in New York State Workforce	10,885	31.16	0.10	0.27

				nonCUNY, Year Entered Bachelor's Program, First Bachelor's College					
7	2	Third Year Wages		‖	‖	5,018	41.73	0.09	0.38
7	3	First Year Wages		Age^2, Dummy Variables for: Additional Majors[b], Transferred to nonCUNY, Year Entered Bachelor's Program, First Bachelor's College	Bachelor's Transfers Who Did Not Receive Bachelor's Degree in New York State Workforce	7,575	26.22	0.06	0.19
7	4	Third Year Wages		‖	‖	3,953	34.42	0.05	0.21

Note: Models were fit using the 'lme4' R software package (Bates, 2015).
[a]Except in the case of Table 8, the constant probability was calculated with the function: 1/(1+e-constant)
[b]Additional majors include criminal justice, business, health, and other majors at entry to associate program.
[c]Additional majors include criminal justice, business, health, other majors, and undeclared at entry to bachelor's program.
[d]Additional majors include criminal justice, business, health, other majors, and undeclared at graduation or during most recent term in bachelor's program.