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How Important Are Community Colleges in Promoting STEM?

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Overview

Community colleges play an important role in delivering Science, Technology, Engineering, and Math (STEM) education to students at the postsecondary level. However, this contribution has been under-recognized, in part because of ambiguous and misaligned definitions of STEM. In this review, we consider how STEM should be defined for community colleges. We argue for an inclusive definition that takes into account the two primary educational missions of community colleges: preparing students for transfer to four-year colleges and universities, and training for positions in the workforce that require more than a high school diploma but not necessarily a bachelor's degree (sometimes called middle-skill jobs). In the STEM fields, transfer-oriented programs include those in traditional academic disciplines, such as biology, psychology, engineering, and mathematics, and may lead to an Associate of Science (AS) or an Associate of Arts (AA) degree; workforce training programs may lead to an occupational certificate or an Associate of Applied Science (AAS) degree in fields like healthcare and information technology. Using an expansive definition—one that takes STEM transfer and STEM technical training programs into account—we find that STEM technical training predominates in community colleges. This is true for program enrollments and credentials conferred. Conservatively, we estimate that 29.8 million U.S. workers have a community college education; of these, 6.6 million (or 22%) are working in STEM occupations. These STEM workers earn 12%–19% more than the average U.S. worker, and they generate total annual earnings of $448 billion. Official estimates appear to undercount the STEM economy, but they undercount the community college STEM economy to a much greater extent.

The community college contribution to STEM education has been under-recognized, in part because of ambiguous and misaligned definitions of STEM.

Introduction

> *Rapid technological advancements and societal changes are our daily reality. While the future of work, the economy, and society is uncertain, one thing is not: To maintain the nation's leadership in science and technology discovery, we must create an approach to science, technology, engineering and math (STEM) education that prepares and advances the U.S. for this future. (National Science Foundation [NSF], 2020, p. 7)*

STEM is widely regarded as critical for economic growth and technical advancement across the U.S. (National Science Board [NSB], 2015). A review by the U.S. Government Accountability Office (2018) found that the federal government commits over $3 billion (2022 dollars) directly into STEM education programs (U.S. Government Accountability Office [GAO], 2018); billions more are invested by state and local governments, private funders, and institutions. Many of these dollars flow directly to colleges and universities to conduct research, teach, and prepare students for careers in STEM. Yet, despite this investment, it is not always clear what STEM means in practice. Looking at STEM initiatives across 14 departments of the federal government, for example, there is inconsistency in terms of what subjects are included and what jobs are classified as STEM jobs (Granovskiy, 2018). Moreover, the definition of STEM has evolved. The STEM Education Act of 2015, for example, incorporated computer science into STEM for federal purposes. Some federal agencies and programs include social and behavioral sciences as STEM, and some distinguish science and engineering (S&E) occupations and degrees from "S&E-related" jobs and degrees. The lack of consensus on what STEM means may have led to overlapping federal STEM education programs (GAO, 2018). Without a clear definition, it is hard to account for federal investments or to assess the effectiveness of policies and programs designed to promote STEM.

The absence of a clear definition of STEM makes it difficult to assess the contribution of the nation's community colleges to STEM education and the STEM workforce.

The absence of a clear definition makes it particularly difficult to assess the contribution of the nation's community colleges to STEM education and the STEM workforce. Community colleges enroll about 35% of all undergraduate students in the U.S. and play a critical role in advancing social mobility for low-income students (Berg et al., 2023; Chetty et al., 2017; Fountain, 2019). Their primary educational mission has two parts: to prepare students for transfer to four-year colleges and universities, and to train students for occupations in the workforce that require more than a high school diploma but less than a four-year degree (sometimes referred to as middle-skill jobs) (Carnevale et al., 2018). In the STEM fields, transfer-oriented programs of study include those in traditional academic disciplines, such as biology, psychology, engineering, and mathematics, that may lead to an Associate of Science (AS) or an Associate of Arts (AA) degree; workforce training programs may lead to a certificate or an Associate of Applied Science (AAS) degree in fields like healthcare and information technology. We argue for an inclusive definition of STEM education that takes both missions—transfer and technical training—into account.

We begin by discussing various definitions of STEM and setting up a framework for understanding how community colleges contribute to STEM education and workforce training. We examine course enrollments, credentials awarded, and occupations and earnings of community college graduates in the workforce. We shed light on the implications of different definitions of STEM in relation to the goals of the community college sector. Our intent is to help build consensus for policymaking and for evaluation purposes. Simply, we will never know if STEM outcomes are improving (or worsening) at community colleges and if public funding should go up (or down) if we cannot identify what STEM is.[1]

Defining STEM

Conceptual Challenges

Any definition of STEM must address several conceptual issues. The first issue is the extent to which science (S), technology (T), engineering (E), and math (M) subjects are separable. If there are clear lines between these subjects, then it should be easy to quantify the amount of STEM programming a college offers or the number of STEM graduates a college produces. In practice, STEM subjects are often intertwined; mathematics, for example, is hard to disentangle from S, T, and E subjects. Separability is even more questionable for technology. Given the capital intensity and computerization of the economy—as well as changes in technological complexity—it may be difficult to identify many college programs or disciplines that are entirely "non-technological." If the definition is restricted to courses that include "T" in their name, then the amount of STEM instruction will almost certainly be undercounted.

A second issue is how much or what type of STEM coursework is needed for a community college student to be recognized as a STEM student. Certainly, a student who completes a STEM credential (however defined) should be classed as a STEM student. Beyond this narrow definition, there are various potential thresholds based on if a student (1) enrolls in developmental (or remedial) STEM (typically M), (2) enrolls in one or more STEM courses but is in a non-STEM program of study, (3) enrolls in a STEM program of study but does not earn a STEM credential, and (4) enrolls in a non-STEM program but transfers to a four-year college to pursue a STEM program. In each of these cases, the aggregate amount of STEM skills is increased. However, most definitions of STEM—including ours—exclude developmental math (category [1]), and often exclude students who take a STEM course or two but either do not enroll in a STEM program or do not earn a STEM credential (categories [2]–[4]). If all these categories were included, STEM education at community college would be much larger than is conventionally reported.

A third conceptual issue is the salience of associated occupations to the definition of STEM in college. In many definitions, this economic link is fundamental: NSB (2015) is explicit in linking STEM education to the work that college graduates do. Much of the focus on STEM is motivated by the expectation that STEM education generates faster economic growth, increases productivity, and promotes greater innovation; presumably these will happen only if students apply their STEM skills in the labor market. If STEM is determined based on STEM skills used at work, then all former community college students who subsequently work in a STEM occupation could conceivably be included as STEM students, regardless of what they studied in college or if they earned a credential. This approach would make the STEM definition much broader.

Responding to the Challenges

Policymakers and researchers have addressed these conceptual challenges in various ways. A common approach is to define STEM narrowly by including only students with awards in subjects that are specifically labeled S, T, E, or M (GAO, 2012). This approach discounts the substantial amount of STEM coursework described in categories (1)–(4) and leaves out many workforce training programs, including those in nursing and other healthcare fields.

An alternative approach is to expand the definition of STEM. This expansion comes either from considering the content of college courses or, more commonly, by making reference to associated skills used in the labor market. Instead of focusing on the names of courses or programs, these broader definitions of STEM reflect that many college programs can teach STEM-related content (e.g., scientific principles) and can lead to employment in STEM sectors. Some federal programs use an even broader definition of STEM education in which foreign languages or the liberal arts are included because they are complementary to, or integrated into, the science curriculum.[2] However, there is less consensus on whether and how to count these subjects as STEM.

At present, various definitions of STEM are being applied across policy and research. In some cases the definitions of STEM are directly contrasting. GAO (2012), for example, includes more college subjects beyond narrow STEM, including agricultural sciences, computer science, and social sciences.[3] Reflecting the labor market, GAO (2012) includes healthcare programs that "train students for careers that are primarily in scientific research" but excludes "healthcare programs that train students for careers that are primarily in patient care, that is, those that [train] nurses, doctors, dentists, psychologists, or veterinarians" (p. 36)—occupations that clearly rely heavily on advanced scientific knowledge. By contrast, NSB (2015) excludes social sciences as STEM subjects, on the grounds that too few of these degrees lead to jobs in STEM, but includes as STEM workers those persons who teach STEM (many of whom have degrees in education), workers in health and architecture, and persons who manage STEM enterprises. The U.S. Department of Labor has its own definitions of STEM that it uses to classify occupations, which we address in a section below.

Researchers use different definitions as well, often due to what is included (or not) in the data sets they are using. Deming and Noray (2020), for example, examine the impact of changing job skills on the labor market returns to STEM majors over a worker's career. Some of their data sources include all physical and life sciences, computer science, engineering, architecture, and social sciences, while another includes only computer science, engineering, physics, chemistry, and biology. Similarly, in a study of science graduation rates among minority students at the University of California campuses, Arcidiacono et al. (2016) include pharmacy, movement science, and statistics but exclude economics, nursing, industrial design, and zoology. Overall, it remains an open question as to what constitutes STEM in U.S. higher education. A clearer, more harmonized definition would help policymaking and research.

Defining Community College STEM Programs

We propose a two-pronged definition of STEM for community college programs of study. Essentially, this definition is derived from the dual missions of community colleges: preparing students for transfer to a four-year institution and training students for technical jobs. These two functional roles are usually distinguished by the credentials that they offer. Students who want to go on to a four-year institution will generally earn an Associate of Science (AS) or Associate of Arts (AA) degree, whereas students in technical programs will generally earn an Associate in Applied Science (AAS) degree or an occupational certificate. We refer to these two functional roles as STEM-Transfer and STEM-Tech.

STEM-Transfer relates directly to programs of study that teach explicitly STEM subject matter: biological sciences; chemistry; earth, atmospheric, and ocean sciences; engineering; mathematics; physics; and mechanic/production technologies.[4] Community college students who complete programs in these subjects can then progress to four-year colleges and pursue the equivalent or a related major. This version of STEM is probably the definition for which there is the most consensus and may be the default definition of many policymakers and researchers. While there is not uniform agreement among policymakers or researchers, we suggest that social and behavioral sciences programs also be included in STEM-Transfer. Courses in fields such as anthropology, economics, political science, psychology, and sociology commonly apply scientific methods, and they typically require students to take college-level math and statistics. Moreover, some social science disciplines overlap with traditional STEM disciplines. Anthropology programs may require a course in human biology, for example, and psychology programs may introduce students to neuroscience.

STEM-Tech refers to the range of technical programs of study and awards that community colleges offer. Including these programs as STEM expands the disciplinary boundary and accounts for the application of STEM skills in the labor market.

It is worth noting that many community college students who intend to transfer do not select a specialized program of study but rather take an array of courses to fulfill general education requirements at a four-year college or university. Such programs of study often include some math and science courses and may lead to an AA in liberal arts or the equivalent. They are an important reason why simply focusing on STEM degrees will result in an undercount of the community college role in STEM education. However, because we cannot be sure of the academic or career goals of students in general liberal arts programs—or know how much math and science they are exposed to—we do not count an AA in liberal arts as STEM-Transfer in the definition we propose.

STEM-Tech refers to the range of technical programs of study and awards that community colleges offer. Including these programs as STEM expands the disciplinary boundary and accounts for the (anticipated) application of STEM skills in the labor market. This is critically important for community colleges, since over half of associate degree programs and more than 90% of certificate programs are directly linked to careers (Carnevale et al., 2020). Based on labor market patterns, we identify a range of disciplines to include as STEM-Tech.[5]

First, we count computer and information sciences (CIS) programs as STEM-Tech. Courses in CIS are demonstrably technological in the sense that they teach students how to construct, operate, and maintain automated systems for use in business and other settings. Computing is increasing in complexity and application (e.g., software, hardware, and communication technologies). CIS postsecondary awards frequently lead to jobs in the information technology sector.

Second, we count health professions programs as STEM-Tech. As noted above, there are differing views as to whether to include health subjects based on the occupations of graduates from health programs. In our definition of STEM-Tech, all health and allied health subjects are included. Given the numbers of enrollees, nursing is perhaps the most salient subject; several studies have argued for its inclusion in STEM (Ganley et al., 2018; Green & John, 2020). Its inclusion may be justified both in terms of what is taught (with multiple sequences in science) and in terms of the occupational trajectory and scientific environment of the workplace (hospital or clinic). More broadly, health awards typically lead to healthcare jobs, often directly via residencies or other forms of work-based experiences. Moreover, these jobs are situated in institutions using technologies that operate broadly on scientific principles and evidence.

We count CIS and health professions programs at community colleges as STEM-Tech.

Finally, we include programs in mechanics, engineering, communication technologies, and general sciences as STEM-Tech. Our reasoning is that these programs are motivated directly toward labor market credentials (certifications and licenses) in occupations that require technological application.

As noted above, STEM-Tech programs may lead to certificates as well as AAS degrees. The scope and intensity of certificate programs vary widely, from courses that are introductory and involve limited technical content (how to use a particular software package, for example) to intensive programs that develop advanced technical skills. It is difficult to make informed judgments about the content or intensity of programs using only national data, though we know from prior research in several states that certificate programs lasting less than one year do not generally lead to wage gains (Belfield & Bailey, 2017). Accordingly, we include only certificate programs lasting at least one year in our definition of STEM-Tech.

Looking across higher education and labor market policy and research, there is no single, agreed-upon view of what programs to include and exclude when examining STEM education in community colleges. Table 1 provides a summary of our recommendations. There may be disagreement on the margins—whether to count social sciences as STEM programs, for example—but our larger point is to ensure that any analysis of STEM in community colleges includes both STEM-Transfer and STEM-Tech. The two functional roles reflect the dual mission of community colleges, and students in both areas make important contributions to the workforce.

Table 1.
Summary of Recommendations for Defining STEM Education in Community Colleges

STEM-Transfer | Programs leading to an Associate of Science (AS) or an Associate of Arts (AA) degree in these fields:

- Computer science
- Life and physical sciences
- Mathematics and statistics
- Mechanic and engineering sciences
- Social and behavioral sciences

STEM-Tech | Programs leading to an Associate of Applied Science (AAS) degree or certificate programs that require at least one year of study in these fields:

- Agriculture and related sciences
- Communication technologies
- Computer and information sciences
- Health professions
- Mechanic and repair technologies
- Other engineering and science technologies
- Precision production

Not included

- Developmental education courses (usually math)
- General liberal arts programs
- Occupational certificate programs of less than one year

Quantifying STEM Education at Community Colleges

In this section, we provide an accounting of STEM within the community college sector. We briefly discuss the prevalence of STEM coursetaking and then develop a catalog of STEM programs and awards. In the next section, we calculate the contribution of community colleges to the STEM labor market.

Broadly, community colleges appear to provide significant amounts of STEM coursework. Prior studies have cataloged this coursework (albeit using a narrow definition of STEM based on college subjects). Examining data from the High School Longitudinal Study of 2009, Chen et al. (2020, Table 3b) report that 88% of students whose first postsecondary enrollment after high school was at a community college attempted at least one STEM course and that of those who attempted any STEM credits, the average STEM credits accumulated over three years was 13. Using data from three state community college systems, Fink et al. (2021) calculate the amount of STEM college-level coursework students take in their first year. Across each student cohort, they find that 19%–34% complete any M credits and that 26%–43% complete S, T, and/or E credits. These two studies use similar definitions of STEM, so the differences in their estimates likely reflect differences in the time period covered (three years in Chen et al. versus one year in Fink et al.) and sample composition.[6]

While course enrollments are informative, they should be interpreted with caution when assessing STEM education and training. A community college may have many students enrolled in STEM courses, but only a fraction of these students may acquire the skills needed for transfer to a bachelor's degree program or for employment in STEM. This is especially true for community college math courses, which are frequently developmental (remedial) courses. Approximately 60% of community college students take at least one developmental math course, and many students who enroll in developmental math courses do not complete them (Chen et al., 2020, Table 1b). While developmental courses are often prerequisites for college-level math, they generally do not count toward associate or bachelor's degrees, and probably few students in developmental math choose to enroll in STEM degree programs or pursue STEM careers.

There are more than three times as many community college students enrolled in STEM-Tech programs than in STEM-Transfer programs.

An alternative indicator of STEM education in community colleges is students' chosen field of study. In Table 2, we show student enrollments by STEM field of study for the spring 2023 semester. The left-hand column counts students in STEM programs of study (including associate degree programs and certificate programs of at least one year in duration) at public two-year colleges; the right-hand column counts students in STEM bachelor's programs at four-year institutions. Reading down the left column, we see that there were just over 345,000 students in STEM-Transfer programs at community colleges, with biology and biomedical sciences and psychology the two most popular programs. There were more than three times as many community college students enrolled in STEM-Tech programs than in STEM-Transfer programs. Health professions are clearly dominant, followed by CIS and mechanic and repair technologies. Altogether, STEM program enrollments account for more than one third of all community college enrollments.

Table 2.
STEM Enrollments per Semester by Program of Study and Type of Institution

	PUBLIC TWO-YEAR COLLEGES		FOUR-YEAR COLLEGES	
STEM-Transfer				
Biological and biomedical sciences	89,440	2.0%	578,690	6.6%
Psychology	86,080	1.9%	524,960	5.9%
Engineering	68,280	1.5%	559,290	6.3%
Social sciences	57,540	1.3%	415,120	4.7%
Physical sciences	20,410	0.5%	117,660	1.3%
Mathematics and statistics	16,280	0.4%	87,370	1.0%
Architecture and related services	7,120	0.2%	52,100	0.6%
Total	**345,150**	**7.8%**	**2,335,190**	**26.4%**
STEM-Tech				
Health professions[a]	690,650	15.6%	948,040	10.7%
Computer and information sciences	227,660	5.1%	595,210	6.7%
Mechanic and repair tech.[b]	106,180	2.4%	6,070	0.1%
Engineering tech.[b]	96,290	2.2%	82,540	0.9%
Precision production	60,230	1.4%	-	-
Agriculture and related sciences	43,290	1.0%	92,340	1.0%
Communication tech.[b]	26,060	0.6%	24,880	0.3%
Science tech.[b]	22,920	0.5%	-	-
Total	**1,273,280**	**28.8%**	**1,749,080**	**19.8%**
STEM total	**1,618,430**	**36.6%**	**4,084,270**	**46.2%**
Non-STEM total	**2,806,790**	**63.4%**	**4,747,060**	**53.8%**
Sector total	**4,425,220**	**100%**	**8,831,330**	**100%**

Source. Berg et al. (2023, Tables 9–11), based on National Student Clearinghouse Research Center data.
Note. Data exclude primarily associate degree-granting baccalaureate institutions (PABs).
[a] Includes related clinical services.
[b] "Tech." includes technologies and technicians.

Turning to the right-hand column, four-year institutions enroll more students than community colleges, so it is not surprising that they have a larger number of students enrolled in most programs of study. What is striking, however, is how much their STEM enrollments are tilted toward the traditional academic programs in the first panel (STEM-Transfer) rather than the applied programs in the second panel (STEM-Tech). Similar to the pattern observed in community colleges, students who enroll in applied programs at four-year colleges and universities strongly favor health professions, followed by CIS. Note that there are no four-year college students enrolled in some technical fields such as mechanic and repair technologies and precision production; these programs are taught exclusively by community colleges.

Overall, Table 2 shows that community colleges enroll 1.6 million STEM students per semester. This is over one quarter of all STEM students and more than one third of the 4.4 million enrollees at community colleges nationwide per semester. Most community college STEM enrollments are in STEM-Tech programs. Counting only traditional academic disciplines—as is often the practice—greatly diminishes the contribution community colleges make to STEM education.

Table 3 presents the number of associate degrees awarded by community colleges, based on 2017 data. As noted earlier, degree counts in STEM and non-STEM fields do not precisely correspond to the amount of STEM skills accumulated by students; STEM graduates may take a nontrivial number of non-STEM courses, for example, and non-STEM graduates and noncompleters may take some STEM courses.[7] Annually, there are 99,810 STEM-Transfer degrees awarded at community colleges (this is likely an undercount of the number of students who transfer to four-year colleges, as some students transfer before completing their community college award).[8] Only about half of these associate degrees are in disciplines that match a narrow definition of STEM; the other half are in social and behavioral sciences.

Table 3.
STEM Associate Degrees per Year

	Associate Degrees at Community Colleges	
STEM-Transfer		
Social and behavioral sciences	48,340	6%
Sciences and math	44,980	5%
Engineering	5,980	1%
Architecture and related services	510	0%
Total	**99,810**	**12%**
STEM-Tech		
Health professions[a]	119,790	14%
Computer and information sciences	28,040	3%
Engineering/science tech.[b]	20,000	2%
Mechanics and repair	12,080	1%
Agricultural and natural resources	8,310	1%
Other manufacturing[c]	6,260	1%
Total	**194,480**	**23%**
STEM total	**294,290**	**34%**
Non-STEM total	**566,140**	**66%**
Community college sector total	**860,430**	**100%**

Source. Derived from tables in Jenkins and Fink (2023), which are based on 2017 Integrated Postsecondary Education Data System (IPEDS) data using a reclassified definition of "community college" that includes many PABs and is thus broader than the definition of "public two-year college" used in Table 2.

Note. Degrees are categorized differently from majors, so Tables 2 and 3 are not exactly aligned by subject.

[a] Includes related clinical services.

[b] "Tech." includes technologies and technicians.

[c] Includes manufacturing, automotive and aeronautical tech., and intelligence and military security tech.

Similar to the pattern observed in Table 2, we see in Table 3 that community colleges award many more associate degrees in STEM-Tech (194,480) than in STEM-Transfer (99,810). More than half of these STEM-Tech degrees are in health professions (and related clinical services), with an additional 15% in CIS.

In total, Table 3 shows that community colleges produce almost 0.3 million associate degrees in STEM each year (or about 0.25 million if social and behavioral sciences are excluded). This represents one third of all associate degree awards across the sector. The remaining non-STEM degrees are often in generic liberal arts or humanities programs, or in occupational fields such as business, police and fire protection, and social services.

Community colleges also provide certificate programs of varying durations. These certificates may be required for work (licenses) or for job tasks (certifications), and they play an important signaling role for employers and prospective clients. STEM-Tech certificates, split by duration into long (greater than or equal to one year) and short (less than one year), are shown in Table 4. Here, we focus on long-term certificates, as prior research suggests that certificates that require more credits have higher earnings gains (Belfield & Bailey, 2017). Certificate programs —short- or long-term—in traditional academic fields that might prepare students for transfer are extremely rare. In contrast, long-term STEM-Tech certificates (of at least one year) are substantial in number: At 83,210, they are 35% of all certificates awarded by community colleges. Continuing the pattern observed in prior tables, certificates in health professions dominate.

Table 4.

STEM Certificates at Community Colleges

	Long-term certificates (1 year or more)		Short-term certificates (less than 1 year)	
STEM-Transfer				
Social and behavioral sciences	200	0.1%	1,020	0.3%
Sciences and math	1,790	0.8%	2,130	0.6%
Engineering	160	0.1%	240	0.1%
Architecture	60	0.0%	610	0.2%
Total	**2,210**	**0.9%**	**4,000**	**1.1%**
STEM-Tech				
Health professions[a]	44,290	18.7%	80,210	21.6%
Computer and information sciences	5,930	2.5%	28,310	7.6%
Engineering/science tech.[b]	7,640	3.2%	19,570	5.3%
Mechanics and repair	13,760	5.8%	28,240	7.6%
Agricultural and natural resources	1,790	0.8%	4,390	1.2%
Manufacturing	9,500	4.0%	22,820	6.1%
Automotive and aeronautical tech.[b]	300	0.1%	600	0.2%
Total	**83,210**	**35.1%**	**184,140**	**49.6%**
STEM total	**85,420**	**36.0%**	**188,140**	**50.7%**
Non-STEM total	**151,740**	**64.0%**	**183,110**	**49.3%**
Community college sector total	**237,160**	**100%**	**371,250**	**100%**

Source. Derived from tables in Jenkins and Fink (2023), which are based on 2017 IPEDS data using a reclassified definition of "community college" that includes many PABs and is thus broader than the definition of "public two-year college" used in Table 2.
Note. Awards are categorized differently from majors, so Tables 2 and 4 are not exactly aligned by subject.
[a] Includes related clinical services.
[b] "Tech." includes technologies and technicians.

This review considers both program enrollments and awards conferred. It shows that conventional definitions significantly undercount STEM at community colleges, not least because they exclude most of the long-term certificates issued each year. However, there is still a significant gap between program enrollment and completion. Indeed, many community college students who begin a program of study do not complete it. Data from the National Student Clearinghouse Research Center (Causey et al., 2022) show that 42% of students who entered a public two-year college in fall 2015 earned a credential from any institution after six years, compared to 69% of students who entered a public four-year institution and 78% of those who entered a private four-year institution. These differential completion rates reveal a "leakier pipeline" at community colleges relative to four-year colleges (van den Hurk et al., 2019). Importantly, the rate of completion for STEM programs versus non-STEM programs in community colleges is very similar (at around one third within three years). Hence, while community colleges need to do more to improve completion rates, the data suggest that students in STEM programs are earning credentials at about the same rate as students in non-STEM programs.

STEM Occupations and Community College

Another way to identify the contribution of community college to STEM is to look at how many community college graduates work in STEM and their relative collective earnings in the workforce. This identification is measured as the number of workers in STEM occupations and how much these workers are paid.

Unsurprisingly, STEM occupations are defined in various ways. Using the 6-digit Standard Occupational Classification system, there are more than 800 separate occupations across the U.S. workforce. STEM occupations are identified based on the sector of work and the tasks required for work within a given occupation.[9] According to the Occupational Employment and Wage Statistics (OEWS) program at the U.S. Bureau of Labor Statistics (BLS), there are 105 STEM occupations. By contrast, the Occupational Information Network (O*NET) Resource Center (sponsored by the U.S. Department of Labor) catalogs 205 STEM occupations. However, these measures do not readily align with the missions of community colleges: Both OEWS and O*NET measures exclude some healthcare and CIS occupations, for example.[10] Therefore, we code each occupation to correspond to STEM-Transfer and STEM-Tech disciplines.[11] This yields 44 occupations with STEM-Transfer workers and 172 occupations with STEM-Tech workers.

To identify the role of community colleges, we match each occupation to its educational requirements and then to its employment and earnings. Two methods are applied to identify occupations that require community-college-level education. One method is derived from occupations being in "Job Zone 3" according to the O*NET classification. Job Zone 3 is an occupation for which an associate degree is the expected requirement.[12] The second method is based on the O*NET-required level of education per occupation: Each occupation is weighted across 12 education levels. We apply weights for education levels at the postsecondary certificate level and associate degree level.[13] Our educational matching is based on the average of these two methods. We derive our results based on this average, using the STEM OEWS and STEM O*NET occupational classifications. These occupations are then matched to their employment levels and earnings from BLS data.

We estimate that more than 6 million U.S. workers have a community college education and are working in STEM occupations.

The national and STEM-specific workforce is shown in Table 5. Of the 148 million U.S. workers, BLS estimates that 14 million (9.4%) are in STEM occupations. However, the OEWS definition is very narrow, so this average is likely to be an undercount.[14] Counting STEM-Transfer and STEM-Tech occupations, the STEM workforce appears significantly larger, at about 23 million (15%).

Community colleges play an important role in educating the STEM workforce, as shown in the right-hand columns in Table 5. Overall, we estimate that 30 million (20%) workers are in jobs that match with a community-college-level education, and many of these workers are in jobs in the 216 occupations classed as STEM.[15] Specifically, there are 0.2 million STEM-Transfer workers across 44 STEM occupations and 6.4 million STEM-Tech workers in 172 STEM occupations. (Again, the OEWS count, which includes many fewer occupations, is much lower.) In total, almost 5% of all workers are in STEM occupations and have jobs that require community college education. Within the community-college-educated workforce, one fifth are in STEM.

Table 4.
Contribution of STEM to U.S. Economy

	U.S. ECONOMY		COMMUNITY-COLLEGE-EDUCATED	
	Amount	**% of Total**	**Amount**	**% of Total**
Workforce (in millions)				
All occupations	147.88	100%	29.8	20.2%
STEM occupations:				
BLS (OEWS/O*NET)	13.89	9.4%	3.0	2.0%
STEM-Transfer	1.46	1.0%	0.2	0.1%
STEM-Tech	21.04	14.2%	6.4	4.4%
Annual earnings per worker				
All occupations	$ 61,900		$57,600	
STEM occupations:				
BLS (OEWS/O*NET)	$105,100		$79,500	
STEM Transfer	$100,100		$73,900	
STEM Tech	$95,700		$69,100	
Wage fund (in $billion)				
All occupations	$9,153.3	100%	$1,712.4	18.7%
STEM occupations:				
BLS (OEWS/O*NET)	$1,447.4	15.8%	$121.0	2.5%
STEM-Transfer	$145.9	1.6%	$12.4	0.1%
STEM-Tech	$2,013.1	22.0%	$435.5	4.8%

Source. BLS (n.d.) (2023 data), O*NET (n.d.-a).
Note. BLS (OEWS/O*NET) average based on identification of STEM occupations. Percentages are relative to all occupations in the U.S.

Using our expanded definitions of STEM-Transfer and STEM-Tech, we find that official estimates disproportionately undercount STEM employment from community colleges. The BLS estimate undercounts STEM employment nationally by 38%, but it undercounts community college STEM employment by 55%. This undercount reflects three factors: The classification of STEM occupations is overly narrow, the proportion of community-college-educated workers in STEM occupations is underestimated, and community college transfer students who complete four-year degrees are grouped into the bachelor's degree category.

Average annual earnings per worker are shown in the middle panel of Table 5. Across the U.S. economy, average earnings are $61,900, but workers in STEM occupations earn substantially more than the national average. For the community college group, average earnings are $57,600 (7% lower than the national average), but here too earnings in STEM occupations are higher than the average. At $73,900 for STEM-Transfer occupations and $69,100 for STEM-Tech occupations, these earnings are 20%–28% more than the national average for persons with a community college education. Official estimates show even higher earnings for STEM workers with community college education (at $79,500, or 38% above the average); this discrepancy arises because official estimates are weighted toward occupations where tasks are almost exclusively STEM related.

Finally, the wage fund—the total labor market based on earnings and workforce size—is shown in the bottom panel of Table 5. The total labor market is $9,153 billion across all 148 million workers in the U.S. economy; 16%–24% of this wage fund derives from STEM occupations. For the community college sector, the wage fund is $1,712 billion, or nearly one fifth of earnings of all U.S. workers. Within this sector, 2.5%–4.9% of the wage fund derives from STEM occupations (again, mostly from STEM-Tech). From this aggregate wage fund perspective, official estimates disproportionately undercount STEM from the community college sector. The national STEM wage fund is undercounted by one third when using BLS occupations, but the community college STEM wage fund is undercounted by almost one half.

Conclusion

Community colleges contribute to STEM education and the workforce in a variety of ways, but it is impossible to determine how much they contribute—or to assess the effectiveness of policies and programs designed to strengthen STEM education in community colleges—without agreement on what constitutes STEM. A narrow definition focuses on transfer-oriented programs in fields like biology, psychology, engineering, and math. A more expansive definition includes technical training programs in fields like healthcare and CIS. As we have demonstrated, most of the contribution in community colleges is in the latter category. Given the scientific knowledge and technical skills that these programs impart—and the types of jobs that students from these programs occupy—we argue that a broader definition is more appropriate and should be adopted by federal agencies and researchers. A broader definition is also more useful for economic analysis of STEM. Community college graduates in the STEM workforce earn considerably more than their peers in non-STEM fields, suggesting that the STEM skills acquired in community college are in demand and are valued by employers. Accordingly, government investment in STEM should reflect this economic potential.

Given the scientific knowledge and technical skills that community college programs in fields such as healthcare and CIS impart—and the types of jobs that students from these programs occupy—a broader definition of STEM education is warranted.

Endnotes

1. The issue concerning the definition and identification of STEM is a precursor to addressing many STEM challenges, including the leaky pipeline, enrollment and completion gaps by race/ethnicity, teacher supply shortages, and low student interest in STEM. See, respectively, van den Hurk et al. (2019), Curran and Kellogg (2016) and Riegle-Crumb et al. (2019), Margot and Kettler (2019), and Sahin et al. (2017).
2. For the Department of Education's National Science and Mathematics Access to Retain Talent (SMART) grants, eligible majors are "in the physical, life, or computer sciences, mathematics, technology, engineering, *critical foreign languages* as defined in section 103(3) of the HEA [Higher Education Act], *or*

a qualifying liberal arts curriculum as an eligible major…" (Code of the Federal Regulations, 34 CFR §691.17, 2014, emphases added).

3. The specific social sciences are psychology, sociology, anthropology, cognitive science, economics, and behavioral sciences.
4. These subjects are in six 2-digit CIP codes (01, 11, 14, 26, 27, 40).
5. These subjects are in 22 2-digit CIP codes with 362 courses at 6-digit CIP code level (Fink et al., 2021; Wang et al., 2022).
6. Chen et al. (2020) include dual enrollment students. Fink et al. (2021) include only first-time degree-seeking students in college.
7. It is unclear which of these opposing forces is stronger. Also, many students receive general transfer degrees.
8. Data on transfers by major who do not complete is not, to our knowledge, available.
9. Thus, occupations are divided into either STEM or non-STEM. Jobs with modest (but non-zero) proportions of STEM tasks are not counted. As a counterweight, work positions in STEM occupations but with few specific STEM tasks are counted.
10. STEM occupations in healthcare are licensed practical and vocational nurses, health information specialists, diagnosing practitioners, and medical registrars. STEM occupations in CIS are research scientists, systems managers, analysts and engineers, programmers, and computer user support specialists.
11. This coding is from the combined list of OEWS and O*NET STEM occupations based on occupational titles.
12. Specifically, Job Zone 3 occupations are ones in which "previous work-related skill, knowledge, or experience is required. … For example, an electrician must have … passed a licensing exam…. Most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate degree. … Employees in these occupations usually need one or two years of training involving both on-the-job experience and informal training with experienced workers. A recognized apprenticeship program may be associated with these occupations" (O*NET, n.d.-b).
13. Thus, both methods do not assign an entire occupation to the community college sector. Instead, each occupation is weighted according to the preponderance of workers with community-college-level education. Also, matching is based on the expected education level for each occupation; individual workers may have less (or more) education than is expected.
14. An earlier NSF estimate (which uses a different definition of STEM) is of 16.8 million workers educated in S&E (with an additional 4.3 million persons not in the labor force) (NSF, 2013).
15. Our estimate does not account for community college students who transfer, earn bachelor's degrees, and enter bachelor's-degree-level STEM occupations; it thus likely undercounts the contribution of community college STEM-Transfer.

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