MIDDLE-SKILL STEM STATE POLICY FRAMEWORK

By Ian Rosenblum and Richard Kazis | OCTOBER 2014

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ABOUT THE AUTHORS

Ian Rosenblum is an education consultant who most recently served as Deputy Secretary to New York Governor Andrew Cuomo for Education & Economic Opportunity, leading policy development and implementation in areas including college and career readiness, community college workforce development and higher education access and success. He was previously a member of Pennsylvania Governor Ed Rendell's Office of Policy & Planning, serving as Secretary of Policy & Planning at the end of the Administration. Ian has focused extensively on pre-k through higher education policy, with additional experience in strategic communication and state budget development.

Richard Kazis is the former senior vice president of Jobs for the Future. His current work focuses on policy and programmatic strategies to strengthen the alignment of regional economic development, workforce development, and postsecondary education. He is also a senior consultant to MDRC.

ABOUT THIS PUBLICATION

In the fall of 2013, Achieving the Dream (ATD) and Jobs for the Future (JFF) began examining how state policy can enable more community college students to earn credentials that provide access to robust and well-paying career opportunities in Science, Technology, Engineering and Mathematics (STEM). In particular, ATD and JFF focused on the role community colleges can play in building supportive pathways for students who might otherwise struggle to complete STEM programs of study. With generous support from The Leona M. and Harry B. Helmsley Charitable Trust, and through intensive collaboration with colleges and state policymakers, our organizations have created this *Middle-Skill STEM State Policy Framework* to help states advance the creation of middle-skill STEM pathways and incent students to enter and complete these pathways.

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Participants in the STEM Regional Collaboratives

- Cuyahoga Community College
- Miami Dade College
- Norwalk Community College
- Ohio Association of Community Colleges
- Florida College System
- Connecticut Board of Regents for Higher Education

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- Oklahoma State Regents for Higher Education
- Virginia Community College System
- Ohio Association of Community Colleges
- Florida College System
- Connecticut Board of Regents for Higher Education

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INTRODUCTION

The sector of the economy frequently referred to as STEM (Science, Technology, Engineering and Mathematics) is the subject of much national interest and debate. While experts agree on the critical importance of STEM jobs to economic innovation and long-term growth, they disagree on a host of questions: What defines a STEM job? How big is the STEM sector? Are there labor shortages in STEM, either overall or in particular fields or regions? Are the STEM education pipelines adequate to meet the demand today and in the near future? Should public policy intervene to promote STEM education and preparation or to entice more STEM-educated individuals to seek employment in the United States? If so, where should federal and state investments be targeted?

These debates are heated. They combine technical arguments with political, frequently ideological, ones. Often, those on one side talk past those on the other: one side warning of a "crisis" and the other decrying a "myth." The public and policymakers are left confused and frustrated.

In this document, we take a different tack. We focus on a specific segment of the STEM economy that has not received adequate attention. It is a segment where there is less controversy about both labor market needs and opportunities—and where there is the potential for significant progress in strengthening the STEM worker pipeline. This is the set of STEM jobs that can be defined as "middle-skill," requiring less than a baccalaureate level of skill. These jobs are far more plentiful than is generally understood, and they pay more than the typical jobs available to those with less than a Bachelor's degree (Rothwell 2013). They are an important and growing source of opportunity for lower-income, less academically prepared individuals, those leaving high school and those treading water in low-wage, low-skill employment. Moreover, they are critically important to America's Innovation Economy and the implementation of new advances that are entrepreneurial, science and technology-rich (National Economic Council 2009; West 2011).

Preparation for a surprisingly large proportion of these jobs now takes place at public community colleges. This presents both an opportunity and a challenge. For students who find their way quickly and efficiently into well-designed and well-delivered programs of preparation for a middle-skill STEM career, the community college provides a relatively low-cost way to dramatically improve their employment, earnings and career trajectory. Yet for a host of reasons, too many community college students have a very different experience, failing to complete their chosen program of study and advance to employment in their field or dropping out before they even make any serious progress toward meeting STEM or other program requirements.

Realizing the potential of community colleges to be the primary source of well-prepared middle-skill STEM workers can go a long way toward strengthening regional economies and the employers that depend upon this segment of the workforce. It can also be a boon to low-income, minority and first-generation students who are disproportionately served in our nation's Associate's degree-granting institutions and who are seeking the stability that a quality job can provide. As Congressman Joseph P. Kennedy III of Massachusetts has written: "STEM lies at the intersection of education, economics, and social justice. It is a vehicle not just for growth and innovation but for access and opportunity" (Governor's STEM Advisory Coucil 2013).

In the following pages, we present a proposal for how to advance the community college middle-skill STEM agenda—and increase the likelihood of successful outcomes for students seeking credentials that will provide them entry into middle-skill STEM jobs. We describe the middle-skill STEM opportunity and challenge in greater detail. We summarize the growing evidence base on what it will take to redesign community college pathways—including STEM pathways—to be more efficient and effective for their students. Finally, we outline a state policy agenda that aligns with this evidence base.

This document has two broad goals. The first is to elevate the middle-skill STEM agenda and its urgency in national debates on both STEM education and postsecondary student success. The second is to articulate a set of policy targets and priorities for states that want to be more active in supporting middle-skill STEM pathways.

We see this as an important step forward, but not the last word. Rather, we hope we have created a living document, one that will be refined over time as the national debate on middle-skill STEM jobs evolves and evidence mounts on effective institutional strategies and policy supports.

THE MIDDLE-SKILL STEM LABOR MARKET: OPPORTUNITY FOR EFFICIENCY *AND* EQUITY

Estimates of the size of the STEM workforce vary greatly because the definitions of which jobs are "STEM jobs" are inconsistent.[1] Recent U.S. Department of Commerce and National Science Foundation estimates differed by 4.8 million jobs, with NSF's count 60 percent higher than that of Commerce (ranging from 12.4 to 7.6 million) (Ebersole 2013).

When definitions are narrowed to professional positions in the economy, there is a relatively broad consensus that STEM occupations represent about four to five percent of U.S. jobs. These are critically important jobs for continued innovation and growth; and those who are employed in this segment of the economy are well-compensated.

However, this narrow definition of the STEM economy renders invisible millions of jobs that are an important engine of economic opportunity, particularly for those with less than a Bachelor's degree. Research by The Brooking Institution's Jonathan Rothwell paints a very different portrait of the economy, highlighting what he calls the "hidden STEM economy." Using the U.S. Department of Labor's O*NET database that details the skills required to perform specific jobs, and defining a STEM job as any job requiring a high level of knowledge in any one of the four core STEM areas (science, technology, engineering and math), Rothwell estimates that one in five jobs in the United States are STEM jobs—20 percent of all employment. Half of these jobs, 13 million in 2011, are available to workers with less than a baccalaureate degree, according to Rothwell. And these middle-skill jobs pay a premium: the $53,000 average wage is 10 percent higher than the average wage for all jobs with similar educational requirements (Rothwell 2013).

Using Rothwell's definition, 30 percent of today's STEM jobs are blue-collar positions; half are in manufacturing, health care and construction. These middle-skill STEM jobs tend to be more evenly distributed across metropolitan areas than professional STEM positions, which cluster in certain metropolitan regions. Rothwell describes the characteristics of middle-skill STEM jobs this way: "These workers today are less likely to be directly involved in invention, but they are critical to the implementation of new ideas, and advise researchers on feasibility of design options, cost estimates and other practical aspects of technological development." As a result, a strong, well-prepared middle-skill STEM workforce is essential to reducing product defects, improving efficiency and achieving quality research and development.

While they do not require Bachelor's degrees, middle-skill STEM jobs frequently require postsecondary credentials—certificates or associate's degrees. The primary higher education institution preparing individuals for these jobs today is the community college. In this role, the community college can be a powerful launching pad for economic opportunity and increased equity. Community colleges help open doors to more advanced STEM education: over 40 percent of STEM bachelor's or master's graduates attended a community college at some point.[2] Given the disproportionately high enrollment of low-income, minority and first generation students in community colleges, effective pathways to STEM jobs can be particularly helpful routes to opportunity for underserved populations, helping to reduce the nation's income, wealth and educational attainment inequalities.

Unfortunately, success in community college STEM programs is far from automatic—or even routine. Although 45 percent of new community college students select programs of study in STEM, including health sciences, according to the National Center for Education Statistics, the majority of students who aspire to a community college credential in a STEM field either leave their program or drop out altogether (Chen 2013). Nationally, more than half of community college health sciences students fail to complete, as do almost three in four computer science students. Although non-completion rates vary by program, overall, fewer than 30 percent of those who enroll in community college succeed in obtaining an Associate's degree within three years, and fewer than half who enter community college with the goal of earning a degree or certificate have achieved their goal within six years (Symonds et al. 2011). With 45 percent of all U.S. undergraduates attending community colleges, completion at these institutions has significant national implications.[3]

AN AGENDA FOR STRENGTHENING COMMUNITY COLLEGE STEM PATHWAYS—AND IMPROVING THEIR OUTCOMES

There are many reasons why different students who enroll in community college have serious difficulty starting and completing a middle-skill STEM pathway—or any community college credential program. Students bring some of these obstacles with them when they enter the community college, such as poor academic preparation (particularly in math), financial strains and the challenges of juggling work, family and studies.[4] Other obstacles are presented by the very structure and institution-wide policies of the typical community college, including ineffective assessment and placement policies; overreliance on stand-alone developmental sequences; unstructured or inefficiently structured program requirements and course sequences; failure to align class schedules so courses are available when students need to take them; insufficient advising on careers, programs, and course-taking; and limited academic and other supports geared to pushing students to timely and efficient completion.

Fortunately, there is a growing body of research, knowledge and experience on what it takes to help more students succeed in community college programs of study, including STEM programs.[5]

Colleges and state systems involved in initiatives and networks such as Achieving the Dream, Completion By Design, Accelerating Opportunity, Complete College America, the Community College Survey of Student Engagement and others have gleaned important lessons about how the highest performing community colleges revamp their instructional programs and student supports to help more students enter and succeed in high-demand programs.[6] After a decade of innovative work, kicked off in large part by the launch of Achieving the Dream in 2004, these lessons are being translated into principles that should inform institutional leaders around the country—and should also inform the decisions of policymakers.

From the perspective of pathways to middle-skill STEM credentials and jobs, research-based reform efforts can be distilled into the following "best practice" principles:

1. **Labor market information:** Program design and curriculum is based upon current regional labor market information and analysis that is fine-grained, up to date, and informed by employers and regional workforce agencies.

2. **Structured pathways:** Programs provide structure and supports for students (e.g., aligned course schedules, educational mapping, curricular guides) and a clearly defined pathway to jobs and careers that are in demand in the regional labor market.

3. **Accelerated and contextualized basic skills:** Students entering college below the necessary level of proficiency receive basic skills support that is accelerated and contextualized for STEM fields, with the goal of minimizing their enrollment in standalone developmental education courses.

4. **Early program enrollment:** Students understand their options through advising upon enrollment and are expected to select a broad meta-major or pathway of study (e.g., STEM, liberal arts) early in their college experience, so that they can move quickly and efficiently to completion.

5. **Intrusive advising:** Early warning systems, frequent and ongoing advising, and career guidance are routine components of student supports and college experience—helping guide students through critical decisions and toward efficient completion.

6. **Supports for persistence:** Students (especially low-income and other underrepresented students) are connected to effective academic, social and financial supports that promote retention and persistence through STEM programs.

7. **Statewide transfer policy:** Associate's degree courses and programs are aligned with those of public four-year institutions in the state, so that transfer to senior institutions to pursue higher-skill STEM programs is seamless and credits transfer efficiently.

8. **Continuous improvement based on evidence:** Student enrollment, persistence, completion, and labor market outcomes are continually monitored—and analyzed by college and major/program—and used for continuous improvement of curricula and support systems.

9. **On-ramps to encourage middle-skill STEM pathways:** High school dual enrollment introduces students to middle-skill STEM careers and provides an early start in earning credit that will transfer toward an Associate's degree or industry credential. In addition—particularly since most community college students are adults—on-ramps that include stackable and latticed credentials build on students' existing academic and work experience.

FIVE RECOMMENDATIONS FOR A MIDDLE-SKILL STEM STATE POLICY FRAMEWORK

In fall 2013, Achieving the Dream, Inc., and Jobs for the Future launched the STEM Regional Collaboratives with support from The Leona M. and Harry B. Helmsley Charitable Trust to implement highly structured middle-skill STEM pathways that adhere to the nine research-based reform principles found on page 6. Through a highly competitive Request for Proposal process, ATD and JFF selected three applicants: Cuyahoga Community College (Tri-C) in partnership with the Ohio Association of Community Colleges; Miami Dade College in partnership with the Florida College System; and Norwalk Community College in partnership with the Connecticut Board of Regents for Higher Education. Each STEM Collaborative brings together college leadership, faculty and staff, local employers, P-12 school partners, community organizations and state partners to create stronger, more efficient middle-skill STEM pathways designed to meet in-demand jobs in local labor markets.

A critical element of this initiative has been working with the state partners in Connecticut, Florida and Ohio to identify state policies supportive of the work their colleges are doing to implement middle-skill STEM pathways. Through numerous meetings, discussions and reviews, we have identified a Middle-Skill STEM State Policy Framework to assist in identifying policy supports that promote the creation and expansion of middle-skill STEM pathways. The following five broad policy recommendations offer a framework for states to advance this vital agenda (*see Figure 1*).

POLICY RECOMMENDATION 1— CREATE PATHWAYS TO CAREERS: ENSURE THAT STEM PROGRAMS MEET EMPLOYER NEEDS

Middle-skill STEM pathways that lead to low-paying, dead-end jobs—or to no jobs at all—are pathways to nowhere for our students. The effectiveness of middle-skill STEM programs therefore hinges on the ability of states to ensure alignment with the current and emerging needs of employers. From using supply-and-demand analysis to make decisions on which programs to offer, to designing curriculum and identifying critical skills, to awarding industry-recognized certifications and other credentials, coordination with employers is essential to putting students on a pathway to viable middle-skill STEM careers.

States can achieve this goal by:

> **Developing systems for using current labor market information and employer engagement to tailor program offerings, curricula and equipment on an ongoing basis.**

Programs that are launched with the best of intentions often lose economic relevance as the labor market changes or workplace skills shift. To address this challenge, states should develop systems and processes that establish continuous engagement and feedback among employers, state agencies (including labor departments, economic and workforce development agencies, and higher education systems), community colleges and students; that use real-time labor market information (LMI) as part of a robust data-informed toolkit; and that ensure programmatic changes occur as needed to reflect emerging employer-driven needs and practices in the relevant STEM fields.

The Dynamic Skills Audit (DSA), developed by Jobs for the Future to assist states, is a structured, data-driven process that utilizes real-time labor market information and highly-structured employer engagement to assess community college curriculum content. Unlike *traditional* LMI sources such as the U.S. Department of Labor's Bureau of Labor Statistics, the Census bureau and the federal O*NET database, *real-time* LMI aggregates online job postings from commonly used job-search websites to identify key industries, occupations and skills within a specified geographic area.[7] In addition to informing supply-and-demand analysis, real-time LMI presents an opportunity to engage employers in ongoing, rigorous strategic conversations that are used to align, adjust and upgrade elements of the programs themselves based on specific employer feedback.

Figure 1 | Five Recommendations for a Middle-Skill STEM State Policy Framework

1. **Create pathways to careers:** Ensure that STEM programs meet employer needs
2. **Open doors to STEM:** Improve math preparation and developmental education to boost student success
3. **Focus on student completion:** Create new models that lead to degree attainment
4. **Make informed decisions:** Improve data collection and data use to enhance transparency, accountability, effectiveness and equity
5. **Provide incentives for success to both students and community colleges:** Encourage innovation and reward better outcomes for STEM students and the STEM workforce

The Kentucky Community & Technical College System has been a leader in piloting the DSA process in all 16 KCTCS colleges.[7] Early findings indicate that the process, bolstered by ongoing technical assistance, has resulted in a more structured and strategic approach to utilizing LMI data as part of the curricula review process and for discussions with industry representatives (*see Figure 2*).

On a regional level, the Workforce Intelligence Network of Southeastern Michigan (WIN) brings together eight community colleges and seven workforce agencies to create a common platform for understanding supply and demand in the regional labor market. Combining information from job postings with conversations with employers, Michigan is effectively using real-time labor market information to tailor community college programs based on "occupational

Figure 2 | Dynamic Skills Audit

The Jobs for the Future Dynamic Skills Audit (DSA) is designed to assess and ensure the alignment between course curriculum and employer needs. The DSA has four components:

> **Step 1. Skills Analysis:** A systematic analysis of skills, certifications, and job performance requirements for each occupation or group of occupations. The audit draws data for the analysis from multiple sources, including O*NET, and places the results in a skills matrix.

> **Step 2. Skills Matrix Development:** The skills matrix compares skill needs in the labor market to the college's courses and their content. This process involves instructors, members of industry advisory panels, and other stakeholders in evaluating and improving course content.

> **Step 3. Assess and Verify with Partners:** A formal assessment of course content and curricula, with recommendations for modifications, additions, and improvements.

> **Step 4. Monitor Skills Demand:** The college institutes ongoing monitoring of real-time labor market developments. This consists of regular reports (quarterly, biannually, or annually) on occupational skills and certifications data generated from a real-time LMI tool and delivered directly to instructors, employer advisory committees, or administrators.

The Kentucky Community and Technical College System has piloted the DSA process and developed the following example of supply and demand analysis for Registered Nurse (RN) and Computer Manufacturing & Machining (CMM) programs at one college:

	DEMAND Traditional LMI						DEMAND Real-time LMI		SUPPLY College & Employment Indicators				Analysis/ Assessment		
Program of Study	2011 Jobs	2008 Jobs	2018 Jobs	10 Year % Change	Projected Annual Openings	2011 Median Annual Wage	2011 Jobs	2010 Jobs	2010-11 # of Students by Program	2010-11 Graduates by Program (KCTCS)	2010-11 All Completions	Job Placement/Entered EMployment	Ratio of 2011 Employed to 2011 Job Postings	Ratio of All Completions to Projected Annual Openings	Job Postings Minus Completions
RN	2,440	2,163	2,634	21.78%	83	$54,401	298	175	160	65	81	82.1%	8:1	1:1	217
CMM	1,130	2,895	2,478	-14.40%	60	$37,000	1,534	683	28	20	46	63.6%	45:1	1:1	1,488

Source: Jobs for the Future; Kentucky Community and Technical College System.

demand, and the skills, educational credentials, and experience needed to work in them" (WIN 2013).

States should consider ways to expand existing regional and institutional successes by taking these models to scale statewide. In addition, states are often uniquely positioned to leverage LMI expertise by strengthening relationships between state-level LMI offices and community colleges. This should include coordination among these partners in order to identify redundancies within and across regions, thus improving efficiency and responsiveness.

> **Aligning career advising between community colleges and feeder high schools.**

The benefits of labor market information and employer engagement in middle-skill STEM programs can be extended into the high school experience, producing at least two benefits: 1) providing students with career information and clear pathways from a much earlier age, and 2) narrowing the preparation gap before students earn their high school diploma. To that end, states should implement policies that align advising between community colleges and their feeder high schools, with a focus on both academic and career and technical education (CTE) programs that prepare students for STEM careers.

The National Governors Association issued a report in 2011 finding that "a student's ability to enter and complete a STEM postsecondary degree or credential is often jeopardized because the pupil did not take sufficiently challenging courses in high school or spend enough time practicing STEM skills in hands-on activities" (Thomasian 2011). Good advising, that points students to solid preparatory courses and experiences, can help bridge that gap. As the U.S. Department of Education has concluded, "Greater alignment between secondary and postsecondary education can promote easier student transitions, less course duplication, and a reduced need for developmental coursework when students enter college" (USDOE 2011).

For example, Oregon's Career Pathways Initiative focuses on the "middle 40"—the 40 percent of Oregon residents who will earn a postsecondary certificate or Associate's degree by 2025 based on the state's established goals. The Pathways, which have been established across all of Oregon's community colleges, include a "focus on easing and facilitating student transitions from high school to community college" and have a particular emphasis on STEM fields. By 2012, Oregon had established more than 350 Career Pathway "'roadmaps' and high school to community college plans of study," which were developed with employer input. An initial study has found positive effects on employment, job retention and continuing postsecondary education from the Career Pathways program (Worksource Oregon 2013).

> **Integrating work-based and contextualized learning into STEM programs.**

Programs serving low-skilled adults have traditionally provided little in terms of short-term economic payoffs that would encourage students to continue, and too often the focus is on low-wage jobs (Milfort & Kelley 2012; Prince & Jenkins 2005). A brief issued by the U.S. Department of Labor's Employment and Training Administration reported that successful career pathways programs partner with industry and employers in program development and that they create "incremental" pathways—"a mix of short-term, moderate-term, and long-term training [that] maximizes participation while promoting job growth" (Gash & Mack 2010).

Contextualization and work-based learning opportunities accelerate the progress of students in career pathways by offering career content immediately, even as they develop their basic skills. They also improve students' motivation to persist in their education and pursue further academic and career courses. In addition, these strategies teach students how to apply their skills and knowledge in the real world.

Work-based learning (WBL) integrates education and training into the workplace, with students able to learn on-site and curriculum adapted to directly meet the needs of employers. For example, the evaluation of Jobs to Careers—an initiative that focused on WBL for frontline health care workers—found that participants had high retention levels and certification rates; two-thirds of program completers received a wage increase; and participants overall reported greater job satisfaction (Morgan et al. 2012; Altstadt, Flynn, & Wilson 2012). WBL has significant benefits for employers, as well, including greater employee retention, cost savings and improved quality and productivity (Altstadt 2012).

Course offerings in GED preparation, English as a second language, developmental education, and general education are all appropriate for contextualization.[8] Washington State's Integrated Basic Education and Skills Training (I-BEST), which combines basic skills and occupational training in the same courses, is considered a pioneer in contextualized instruction for adults. Quasi-experimental studies have found that I-BEST students complete more credits, have higher persistence rates and are more likely to earn a certificate than their peers (Jenkins, Zeidenberg, & Kienzl 2009; Rutschow & Schneider 2011).

> **Establishing employer incentives for internships, co-ops, apprenticeships, externships and other work-based learning opportunities that lead to jobs and job experience for students.**

Connecting students in middle-skill STEM programs with employment experiences through apprenticeships and similar programs while they complete their academic coursework can encourage persistence toward completion, ensure the relevance of STEM programs and strengthen the links between community colleges and regional employers.[9] States should provide financial incentives, such as tax credits or grants, to encourage employers to invest in offering these experiences. In addition, by focusing eligibility for these financial incentives on STEM career pathways that are supported by LMI and programs that lead to high-demand skills and certifications, states can maximize their financial investment and encourage community colleges and their employer partners to develop effective programs.

For example, the SciTechsperience program in Minnesota provides state funding to cover up to half of the compensation for STEM students at community colleges and other higher education institutions that participate in internships with small- and mid-sized employers; funding has been appropriated for at least 125 STEM internships in 2014-15.[10] Similarly, Ohio Means Internships and Co-ops combines state and private funding to increase opportunities for students and employers to benefit from work-based learning experiences. Colleges and their partners compete for funding to establish internships and co-ops; matched private funding is required. A web portal allows students to search opportunities and post resumes, and employers to seek out talent.[11]

> **Aligning middle-skill STEM programming with state economic development strategies.**

A 2011 survey of U.S. manufacturing companies conducted by Deloitte for The Manufacturing Institute found 83 percent of employers citing moderate-to-serious shortages of skilled workers.[12] As states compete to recruit and retain companies that support middle-class jobs, developing the middle-skill STEM workforce and pathways to higher-skill STEM jobs should be viewed—and articulated—as a critical economic development strategy and included in site selection decision-making and incentive packages.

In Massachusetts, the state's official strategic plan for job growth includes "advanc[ing] education and workforce development for middle-skill jobs through coordination of education, economic development, and workforce development programs" as one of its five pillars. The strategy is highly focused on STEM careers, and includes improving responsiveness to STEM employer needs (Bialecki n.d.). As another example, Oklahoma's "OneOklahoma" initiative is a strategic plan for science and technology.

The plan articulates a connected vision and concrete recommendations for STEM economic development by linking strategies at the K-12, higher education, research and development, and industry levels (Oklahoma Governor's Science and Technology Council 2012).

One promising STEM economic development strategy, pioneered by Pennsylvania, is the establishment of structured industry partnerships that bring together employers, education providers and workforce agencies. By 2011, Pennsylvania had trained over 91,000 workers and job-seekers in 11 targeted industry sectors through more than 60 partnerships, representing 6,300 employers as well as labor organizations and higher education and workforce development stakeholders. Employers reported an 88 percent satisfaction rate with Pennsylvania's industry partnership initiative, and 84 percent said it led to an increase in productivity (Herzenberg 2011). In 2013, Maryland launched the Employment Advancement Right Now (EARN) to fund industry partnerships primarily in middle-skill, STEM fields.[13]

POLICY RECOMMENDATION 2— OPEN DOORS TO STEM: IMPROVE MATH PREPARATION AND DEVELOPMENTAL EDUCATION TO BOOST STUDENT SUCCESS

Math achievement represents a unique, pressing and persistent barrier to success for many students in middle-skill STEM programs—a crisis point that states must address in order to truly develop pathways to program completion. Approximately 60 percent of community college students are referred for at least one developmental course, and more than 3 in 4 of these students fail to earn a degree or certificate within eight years (Bailey & Cho 2010). Students are nearly 80 percent more likely to place into developmental math than developmental reading, and students who are underprepared in math are unlikely to complete the developmental program and persist to successfully earn a credential (Bailey et al. 2012; Hodara 2013).

States can redesign math preparation for STEM pathways—and therefore more broadly improve outcomes in programs that lead to middle-skill STEM careers—by:

> **Reducing time and improving structure to accelerate and contextualize developmental education.**

A growing body of research points to the ineffectiveness of traditional developmental math (Bailey 2009; Calcagno & Long 2008; Scott-Clayton & Rodriguez 2012). States should encourage colleges to implement established successful alternatives, provide necessary support and assistance, and ensure that they are implemented at scale.

Key strategies include:

» **Placing students** who are near the developmental cut-off directly into college-level courses *while* providing simultaneous additional supports to address their academic gaps;

» **Working with K-12 partners** to improve and align the curriculum between high school and college-level math, helping to reduce the need for developmental education;

» **Providing professional development** to advisors on keeping STEM-aspiring students interested in STEM, even if they need additional math preparation;

» **Accelerating the acquisition of basic math skills** for students who need greater levels of developmental education, including through the use of intensive or compressed instruction; and

» **Contextualizing math developmental education** in order to improve engagement and effectiveness, as described above.

The California Acceleration Project implemented multiple strategies that reduced developmental education by at least one semester in 16 community colleges, relying primarily on changes in instruction and professional development for faculty. Researchers found that students participating in accelerated math pathways were

4.5 times more likely than students in traditional developmental education to complete a transferable college-level math course (Hayward & Willett 2014). Students were most successful when developmental education was most accelerated.

In 2012, Connecticut (a participating state in the STEM Regional Collaboratives) enacted a law to redesign developmental education—accelerating remediation and placing students directly into college-level courses where possible. Legislation is not always the most effective means of encouraging colleges to change. Encouraging behavior via incentives, guidance or college-led initiatives can be equally if not more effective. Nonetheless, the Connecticut colleges must implement the law, and so they are working hard to do so effectively. The Connecticut model has two tiers for students who are not yet college-ready:

1. For students at or near 12th-grade skill levels, "just in time" embedded developmental education that functions as a co-requisite for college-level coursework allows students to enroll in college-level courses immediately
2. For students below 12th-grade skill levels, they take either a single semester of developmental education or an intensive college readiness program designed to enable students to take college-level courses with embedded support within one semester.[14]

Connecticut's co-requisite model is based upon the success of the Accelerated Learning Program (ALP) at the Community College of Baltimore County, which places students—who would otherwise be placed into a pre-requisite developmental course—into college-level English composition, while providing extra supports through a three-credit co-requisite support course that meets immediately after to provide students with just-in-time basic skills support. Evaluations by the Community College Research Center have found that students pass the introductory college-level course and the subsequent English course at substantially higher rates than their peers not in the ALP (Cho, Kopko et al. 2012; Jenkins, Speroni et al. 2010).

Another important strategy is to consider alternatives to placement tests alone in determining whether developmental education is necessary in the first place. Research suggests that existing placement instruments alone are not good predictors of student success in college, and that other measures, such as GPA, can work as well, if not better, for determining student placement (Burdman 2012; Belfield & Crosta 2012; Scott-Clayton 2012). In reaction to this research, in 2013 North Carolina adopted a statewide "multiple measures" policy establishing a hierarchy of three measures to use when determining if a student is prepared for college-level coursework: first, high school GPA; second, ACT or SAT scores; and third, placement test scores. Colleges have until fall 2015 to implement the new policy.

California's Long Beach City College (LBCC) launched a partnership with the local school district in response to alarming data revealing that more than 90 percent of LBCC students were placing into developmental education, and on average, students were taking about 5.6 semesters worth of developmental work (RP Group 2012). Through an analysis of its data, LBCC learned that while high school GPA and grades were the strongest predictors of student performance in college-level LBCC courses, GPA and grades were, in their words, "virtually unrelated" to placement into developmental education courses (Rivera 2012). The college launched a district/college collaborative to improve graduation rates for local students called Promise Pathways. The college and high school faculty have worked to align the curriculum, and the college will place new students using high school transcripts and grades rather than an assessment test (Puente 2012). In the first year, successful completion rates of transfer-level English increased from 12 percent to 41 percent, while successful completion of transfer-level math increased from 5 percent to 15 percent (Oakley 2014). To spread

LBCC's success to other colleges, the California Community College's Chancellor's Office is studying whether all 112 community colleges in the state ought to use GPA and high school transcripts for placement (Rivera 2012).

> **Aligning math requirements with STEM program expectations and establishing differentiated math pathways based on the content that students need.**

Establishing clear math pathways for students based on their starting point and their planned course of study can result in a transparent, streamlined and condensed trajectory. States should implement multiple math pathways to improve persistence and completion while ensuring rigor and transferability. The goals of differentiated math pathways include ensuring that:

» Students are taking relevant and appropriate courses for their career goals.

» Students are not unnecessarily stymied by college algebra if their academic program does not require algebra (Bryk & Treisman 2010; Shaughnessy 2011).

» Teaching and student success is improved for those who need the traditional algebra to calculus pathway, including for many (though not all) STEM programs.

The New Mathways Project (NMP) at the Charles A. Dana Center at the University of Texas at Austin is an evidence-based redesign of college math courses and sequences to successfully move students through both developmental and college-level math in no more than one year (*see Figure 3*) (Charles A. Dana Center 2012). The New Mathways Project has been adopted by all 50 community college districts in Texas.[15]

The New Mathways Project is developing math pathways in statistical reasoning, quantitative reasoning, and STEM prep. For the STEM prep pathway, which is currently under development, NMP is working closely with teams of faculty and student success professionals to create math pathways that emphasize improved teaching as well as a focus on student persistence—featuring strategies designed to maintain high aspirations among STEM-interested students. NMP's work has not yet been rigorously evaluated, but it shares many characteristics of the differentiated

Figure 3 | New Mathways Project

The Charles A. Dana Center at the University of Texas at Austin designed the New Mathways Project based on "rigorous, transferrable, college-level content that meets the requirements of specific academic programs and careers."

The New Mathways Project pathways are designed for students who have completed Arithmetic or who are placed at a Beginning Algebra level. Students start with a quantitative literacy-based introductory course that prepares them for college-level math. Students also take a co-requisite research-validated student success course designed to promote mastery of the skills they need to succeed in college, such as self-regulated learning. In the second semester, students move into one of the three college-level math pathways that are aligned to the math requirements of specific academic programs and careers:

> **Statistics:** relevant to the education and career goals of students in the humanities or social sciences;

> **Quantitative Literacy:** for students looking to build their quantitative literacy skills in ways that will support their professional, civic and personal lives; and

> **STEM Prep:** for students pursuing degrees and careers in science, technology, engineering, and mathematics.

Source: Charles A. Dana Center at the University of Texas at Austin.

pathways of the Statway™ and Quantway™ programs. Statway and Quantway also align the curriculum to program requirements and offer students a one-year pathway through both developmental and college-level introductory math. In Statway's first year of implementation, 88 percent of students who passed the first term with a C or higher subsequently enrolled in a second term; before Statway, only 25 percent of students with a C or higher re-enrolled.[16]

As the New Mathways Project makes clear, math requirements do not need to be identical when program requirements and expectations can differ significantly based on content area (Bryk & Tresiman 2010). Instead, states should align math requirements with the actual math needed to succeed in middle-skill STEM programs and adopt consistent statewide requirements to facilitate transfer to Bachelor's degree programs. Differentiated requirements do not and should not mean less rigor; to the contrary, they can ensure that students are strongly grounded in the skills they will need for their career—while improving relevance and reducing unnecessary developmental education and the attendant high dropout rates.

For example, Virginia implemented a statewide developmental math redesign initiative with a straightforward principle: "students only take the math they need" (Asera 2011). Virginia's model creates nine modules of math curriculum; students are required to complete only the modules that they need based on 1) their demonstrated skill levels, and 2) the requirements of their program of study. Math requirements differ for STEM and business administration pathways, liberal arts pathways, and career and technical education pathways (Serbousek n.d). A study on the first cohort of students to experience the redesign found that the percent of students who placed into and successfully completed college-level math more than tripled (both for students overall and for STEM students specifically), although the aggregate pass rate in college-level math decreased moderately (Rodriguez 2014).

> **Investing in professional development leading to improved teaching and student success.**

Improving math preparation and developmental education calls for significant programmatic changes, which means that those in the classroom—the faculty—are not only integral to the success of reform but are also uniquely positioned to inform and lead major elements of the agenda. States should support community colleges adopting implementation strategies that include faculty in leadership roles and that establish professional development as an essential element of reform, including through appropriate investment and ensuring participation and fidelity.

Research on high-performing organizations highlights the importance of frontline employees understanding and embracing changes in their organizations. In keeping with this research, studies of the slow rate of change in higher education point to the need to do a better job of communicating with and empowering faculty (Bacow et al. 2012; Jenkins 2011; Public Agenda 2010). The interim evaluation of the Achieving the Dream initiative emphasized that the participating colleges needed to include more faculty in leadership roles, concentrate more directly on improving instruction, and do a better job of engaging adjunct faculty (Rutschow et al. 2011).

In Virginia, for example, faculty professional development was explicitly articulated as a critical strategy for bringing developmental education redesign to scale. The Virginia Community College System offers an annual developmental education symposium, an annual developmental education institute and "quick track" online webinars for faculty (Healy n.d.).[17]

> **Using technology to customize instruction and accelerate developmental education.**

To support developmental math reform and ensure that it is brought to scale system-wide, states should explore the use of technology tools that customize and accelerate developmental instruction. In particular, states should expand the use of faculty- and student-driven technology tools and strategies like blended learning which, unlike distance learning, maintains the campus as the hub of learning and supports and emphasizes the essential role of faculty, while enabling students to learn at their own pace and receive personal assistance when needed.

Virginia's developmental math redesign relies on computer-mediated instruction at community colleges to personalize the learning experience as students progress through the modules they need. In large part due to the flexibility enabled by technology, students who require multiple modules can enroll in variable-credit shell courses of up to four credits that can last as long as a full semester (Edgecombe & Bickerstaff 2014).

There are many technology platforms that states can evaluate and support their colleges in implementing. MyMathLab—a set of online courses that typically complement classroom instruction—is just one example. MyMathLab has been used by more than 4 million students at 1,850 colleges and universities since 2001. A study conducted at Houston Community College found that students who used MyMathLab had 22.7 percent higher college-level Algebra retention rates in one semester and 32.3 percent higher retention rates in another semester compared to students who completed only textbook-based homework (Speckler 2009).

POLICY RECOMMENDATION 3—FOCUS ON STUDENT COMPLETION: CREATE NEW MODELS THAT LEAD TO DEGREE ATTAINMENT

Even beyond developmental education, college completion remains a challenge of epidemic proportions. As the U.S. Department of Education reported: "A total of 48 percent of Bachelor's degree students and 69 percent of Associate's degree students who entered STEM fields between 2003 and 2009 had left these fields by spring 2009. Roughly one-half of these leavers switched their major to a non-STEM field, and the rest of them left STEM fields by exiting college before earning a degree or certificate" (Chen 2013).

To address this STEM attrition crisis, states should establish clear, structured routes through college—often referred to as accelerated, structured pathways to completion. Structured pathways represent a holistic reform agenda, redesigning how students experience college from their point of first connection through to completion and into the labor market. A key emphasis for structured pathways is that colleges plan to transform their students' experiences through a series of strategic, coordinated reforms—rather than a combination of disconnected, discrete interventions. Structured pathways drive toward helping students enroll early in program streams that lead to a major and keeping students engaged and progressing until they complete credentials with labor market value. They are often characterized by: systemic use of real-time LMI; accelerated developmental education; streamlined programs of study; wrap-around student supports; and tracking and analysis of student outcomes.

To develop meaningful structured middle-skill STEM pathways, states can link and align a number of strategic policies:

> **Offering dual enrollment for high school students to earn college credit.**

Beginning pathways in high school with dual enrollment programs that enable students to simultaneously earn high school and college credit is a proven strategy for preparing students for careers and improving their college success rates. States should develop dual enrollment programs that are part of structured, coherent pathways to STEM careers.

A Community College Research Center overview of research on dual enrollment reported that student participation is positively related to higher GPA, more credit accumulation and higher rates of college enrollment and persistence (Hughes et al. 2012). In addition, according to the Education Commission of the States, CTE students who participate in dual enrollment are more likely than students who did not engage in dual enrollment to earn a high school diploma, enroll in a bachelor's degree program, not need developmental education in college and persist to college completion (Dounay Zinth 2014).

In North Carolina, the Career & College Promise program provides three structured dual enrollment pathways for high school students, all of which are fully transferable to the state's university system and/or result in a credential for a technical career; the program is free for high school students who maintain at least a 3.0 GPA.[18] Tennessee's Seamless Alignment and Integrated Learning Support (SAILS) initiative provides a targeted math dual enrollment pathway for students who score below 19 on the ACT during their junior year; these students are subsequently required to take a Bridge Math course and, upon successful completion, can take a tuition-free college math course before finishing high school.[19]

States should also consider Early College High School STEM pathways, which provide up to two years of college credit by the time students earn their high school diploma.[20] Earlier this year, Texas launched a CTE Early College High Schools Initiative, which will enable students to earn a stackable industry-recognized credential, at least 60 credit hours toward an Associate of Applied Science degree, or a completed AAS degree.[21] In New York State, the Pathways in Technology Early College High School (P-TECH) program will launch in 16 high schools in fall 2014 and in up to 10 more schools in fall 2015, bringing together high schools, regional STEM employers and local colleges, and resulting in a free Associate's degree for participating students, who will be first in line for a job with the STEM employer upon successful program completion (*see Figure 4*).[22] Connecticut's first P-TECH program likewise opens in September 2014, as part of a comprehensive state-led initiative to prepare

Figure 4 | Pathways in Technology Early College High School (P-TECH)

In 2011, the City University of New York (CUNY), IBM and the New York City Department of Education launched a partnership called P-TECH designed to provide at-risk students with a 6-year STEM career and technical education program that leads to a high school diploma, an Associate of Applied Science degree and a job in Information Technology.

While the initial cohort of P-TECH ninth graders is entering its senior year of high school, the P-TECH model of STEM CTE dual enrollment partnerships among K-12, community colleges and regional employers has received national attention and is being replicated statewide in New York State as well as in Chicago and Connecticut.

The P-TECH model is based on four key principles:

> **STEM Focus:** Each program provides a rigorous and relevant education that prepares students for a STEM career.

> **Workplace Learning:** Students receive ongoing mentoring, worksite visits, speakers and internships.

> **Dual Enrollment:** By the end of the sixth year, students earn an Associate of Applied Science degree in a high-tech field at no cost to the student's family.

> **Future Employment:** Students are first in line for a middle-skill STEM job with the participating employer following completion of the program.

Source: New York State Education Department.

students for the workforce. Norwalk Community College, a participant in the STEM Regional Collaboratives, is a key partner in launching the school.[23]

> **Organizing meta-majors at community colleges to encourage early selection of a career cluster.**

Community colleges often wait too long to ensure that students have selected a course of study—leaving many to falter and drop out before they can find their pathway to success. In California, for example, only roughly half of community college students even enter a program of study—with the remainder dropping out before they select a pathway (Moore & Shulock 2011). To get students on track to success from the beginning of their academic career, states should organize and encourage the early student selection of "meta-majors" that provide a clear trajectory for academic requirements and program completion.

As defined by JFF and a number of its partner national higher education leadership organizations, meta-majors are "a set of broad content areas that students choose upon enrollment at a postsecondary institution. A meta-major includes a set of courses that meet academic requirements that are common across several disciplines and specific programs of study. Enrollment and completion of meta-major courses guide students through initial academic requirements and into programs of study" (Charles A. Dana Center et al. 2012).

In 2013, Florida passed legislation that established eight meta-majors (one of which is STEM) and aligned its gateway course requirements to each meta-major based on the academic expectations of its programs of study (Florida participates in the STEM Regional Collaboratives). Thus, entering students will now select a meta-major and receive advising based on the particular meta-major's requirements (*see Figure 5*).[24] Miami Dade College in Florida is expanding upon the meta-majors concept to create Communities of Interest (COI) for their

Figure 5 | Florida Meta-Majors

To help students affiliate with a course of study as early as possible and develop a clear trajectory to completion, Florida enacted legislation creating "meta-major" academic pathways. Every institution in the Florida College System must incorporate meta-majors into their advising systems, and gateway course requirements are based on the meta-major that a student selects, resulting in differentiated pathways.

Florida has established eight meta-majors:

- Arts, humanities, communication, and design
- Business
- Education
- Health sciences
- Industry/manufacturing and construction
- Public safety
- Science, technology, engineering, and mathematics
- Social and behavioral sciences and human services

Source: Florida Department of Education.

students. COIs are an innovative approach to integrating academic and student supports (Miami Dade Colleges participates in the STEM Regional Collaboratives). Miami Dade's COIs will link the meta-majors to wrap-around student supports that align with the students' academic and career interests. In the College's own words, COIs "provide a set of courses, faculty, mentors, coaches, tutors and other supports to ensure that students with common areas of interest receive both appropriate, contextualized curriculum and relevant support services."[25]

> **Establishing structured pathways and related supports that reduce information overload.**

Many recent trends in community college reform and research indicate the need for fewer decision points for students and more guidance and structure as they navigate their academic experiences (Scott-Clayton 2011; Jenkins & Cho 2012; Karp 2011; CCCSE 2012; Schwartz 2004). Lack of structure and support leave students without a clear pathway to degree completion, resulting in the low persistence rates described above. States should encourage their colleges to establish streamlined, clearly defined pathways through strategies including better mapping, course scheduling that aligns with student needs, stacked and latticed credentials, intrusive advising, and degree maps.

For example, Guttman Community College has linked structured pathways with enhanced supports for its students and very clearly articulated academic expectations. The City University of New York community college provides intensive advising including a "student success advocate" assigned to each student, sample schedules and a summer bridge program. Students are required to attend full-time during their first year and have a highly structured schedule for two of the four terms that make up the first-year program.[26] Guttman—the first new community college created by the City University of New York in forty years—is an example of how a state can encourage colleges to build student structures that adhere to the latest research on student success (Scrivener, Weiss, & Sommo 2012).

> **Creating highly structured transfer pathways with guaranteed transfer of credits and credentials.**

As described above, stackable credits and credentials of varying length—which are additive toward degrees or credentials as students gain and demonstrate additional skills—help establish multiple pathways that lead to middle-skill STEM credentials with value in the workforce and/or to a Bachelor's degree; however, these pathways are only possible in practice if states are held accountable for implementing strong transferability systems. States should ensure that credits, credentials and degrees are appropriately rigorous and fully transferable, including through statewide common numbering, core-to-core program transfers, greater transparency for students, stacking and latticing of credentials, and the support of cross-sector faculty conversations that ensure that the learning outcomes of community college programs align with the specific major requirements of partner four-year institutions. Additionally, states should work to link non-credit STEM training to opportunities for study in credit courses, certificates, and degrees in STEM fields including common admission policies, supports for students, and clear information on stackable credentials. Cuyahoga Community College's "One Door, Many Options for Success" effort, funded in part by the Cleveland Foundation, is a strong example of these types of activities (Cuyahoga Community College participates in the STEM Regional Collaboratives). In keeping with national efforts to ensure that students receive a full suite of options and supports regardless of how they access a college—often referred to as the "No Wrong Door" approach—Cuyahoga's initiative seeks to better integrate the College's workforce and academic sides of the college, and provide clear pathway information for students seeking opportunities, regardless of whether they enter through workforce or academic programs.

Students who meet core course admissions requirements are far more likely to graduate within six years than are transfer students with a deficiency in core requirements (Belieu 2010).

Likewise, students who transfer after receiving an Associate's degree are far more likely to earn their Bachelor's degree within four years than students who transfer without an Associate's degree (National Student Clearinghouse 2012). CCRC has released an analysis of transfer in North Carolina that found that students who transferred with an associate degree were 49 percent more likely to complete a Bachelor's degree within four years (Crosta & Kopko 2014). In addition, a recent AERA report found that the more credits a student loses upon transfer, the lower that student's likelihood of completing a Bachelor's degree (Monaghan & Attewell 2014).

States can incent the creation of cross-sector partnerships that lead to highly structured transfer pathways, such as that exemplified by Arizona State University and Maricopa Community College. The colleges teamed up to build the Maricopa-ASU Pathways Program (MAPP), which seeks to build deliberate pathways from Maricopa into ASU. Benefits to students include guaranteed admission to ASU if all MAPP requirements are met; assurance that all courses will transfer and apply to an ASU degree; access to tools that allow students to track degree progress; and access to student supports and events.[27]

To facilitate transparency for students, the institutions created a far-reaching web portal. The website lists phone and email addresses for both ASU and Maricopa transfer staff who can assist students with the transfer process. Maricopa students can see online which two-year courses fulfill ASU's 100- and 200-level course requirements in their degree field. The Pathway Tracker allows students to track their progress toward completion and identify which courses they still need to finish, generated by real-time transcript data. The portal also outlines transfer eligibility, provides information on financial aid and gives students a checklist to help them evaluate their readiness for a pathway program (Altstadt et al. 2014).

In addition to incenting cross-sectoral partnerships, states can institute important policies that serve as foundations of good transfer policy. For example, Florida, Colorado, North Carolina, Washington, and Kentucky are among the states that have adopted common course numbering to improve transferability and transparency. Kentucky's longstanding leadership in this area also includes a strong statewide transfer policy and priority admission and junior-level status for students who meet general education requirements and transfer to a public four-year institution with an Associate's degree from the Kentucky Community & Technical College System.[28] In North Carolina, the state updated its longstanding transfer policy agreement earlier this year in order to create clearer pathways for students to transfer from community colleges to four-year institutions, ensure that foundational courses will transfer and count toward general education requirements, and encourage students to earn an Associate's degree before transferring.[29]

POLICY RECOMMENDATION 4—MAKE INFORMED DECISIONS: IMPROVE DATA COLLECTION AND DATA USE TO ENHANCE TRANSPARENCY, ACCOUNTABILITY, EFFECTIVENESS AND EQUITY

Strengthening the middle-skill STEM pipeline so that community college programs are more likely to result in degree completion and post-completion employment is essential to filling projected job openings and enhancing the nation's economic recovery. A key focus—and critical contribution—of the past decade of work advanced by the Achieving the Dream National Reform Network has been to encourage colleges and their state partners to embrace data and create a culture of inquiry and evidence. To that end, to measure progress, identify promising practices and make course corrections where needed, states must have robust data systems and ensure their transparency and use.

States can establish strong data collection and use policies that promote student success by:

- **Adopting public goals for STEM degree and certificate production, with metrics and strategies for improvement and accountability for demonstrating progress.**

  States cannot know if they are successfully implementing a middle-skill STEM opportunity agenda unless they actually quantify the number of additional STEM degrees and certificates they hope to award and set meaningful targets for reaching that goal. States should adopt public goals consistent with their local priorities that help to set expectations statewide for student completion and employment in middle-skill STEM fields. Kentucky's Stronger by Degrees agenda, for example, has long used specific statewide and institutional performance metrics to monitor degree attainment and graduation rates (Kentucky Council on Postsecondary Education 2011).

- **Ensuring transparency around student progress, completion and employment outcome data by program.**

  The use of data must extend beyond aggregate goals to include key evidence-based benchmarks along the educational pipeline—following students from enrollment to persistence to completion and ultimately to employment. Examples of performance indicators adopted by the Completion by Design colleges include, for example, the proportion of students who start below college level and complete recommended developmental education with one year; the proportion of students earning 12 college credits in one year; and the proportion of students who enter a program of study within one year. The National Governors Association has also established Common Completion Metrics to advance this goal and promote consistency across states. Key features of the NGA approach include the ability to examine the success of students who require developmental education, first-year success and persistence, credit accumulation and time to degree.[30]

  In addition, data is used most and best when it is specific and relevant; states should therefore make data transparent at the campus- as well as state-level and within campuses by major and program of study—so that STEM programs can be identified, for example.

  Linking postsecondary data to workforce outcomes remains an outstanding need in the majority of states. By using higher education records and state unemployment insurance or other data typically collected by state labor agencies, some states now have the ability to determine whether former students gained employment and/or improved their wages following program completion. For example, at the state level, Oklahoma publishes an annual "Employment Outcomes Report" that shows employment rates and average wages by program of study, and the Florida College System maintains a website called Smart College Choices that allows prospective students to analyze student outcomes—including percent employed and wages—by college and program.[31] According to the Data Quality Campaign, as of 2013, 24 states link postsecondary and workforce data systems, an increase from 14 states in 2011—though the use and transparency of the data differs significantly from one state to another.[32]

- **Ensuring transparency around student outcome data disaggregated by population subgroups and establishment of goals for reducing attainment gaps.**

  African-Americans, Hispanics and Native Americans represent 26 percent of the U.S. adult population over 21 years old, but hold only 10 percent of the nation's STEM jobs; and while just over half of Americans are women, female workers constitute only 28 percent of the STEM workforce (National Science Board 2014). With the significant potential for economic opportunity created by STEM careers over the next decade, states should ensure that *all* of their residents benefit—particularly those who have traditionally been underrepresented in STEM fields.

  States can address this critical issue by ensuring that disaggregated data is collected, used for goal-setting and accountability, and is fully transparent to the public. Disaggregation should include gender, race and ethnicity, English language learner status, economic disadvantage, and full- and part-time student status. States should establish enrollment, persistence, completion and labor force goals for these groups, as well as goals for closing attainment and success gaps.

Kentucky's Stronger by Degrees performance metrics explicitly include graduation rate gaps of underrepresented minority, low-income and underprepared students at the statewide and institutional levels (Kentucky Council on Postsecondary Education 2011). The University of Hawai'i System's Hawai'i Graduation Initiative includes scorecards for each college detailing progress on total degrees and certificates earned by Native Hawaiians—a key focus population for the system—and in STEM fields.[33] And in Virginia, the Virginia Community College System's six-year strategic plan includes campus-level quantifiable targets for access, student success and other goals.[34]

POLICY RECOMMENDATION 5—PROVIDE INCENTIVES FOR SUCCESS TO BOTH STUDENTS AND COMMUNITY COLLEGES: ENCOURAGE INNOVATION AND REWARD BETTER OUTCOMES FOR STEM STUDENTS AND THE STEM WORKFORCE

Consistent with the collection, use and transparency of data described above is the importance of alignment of incentives at the institutional and individual levels to encourage the development of a strong middle-skill STEM workforce. States should adopt strategies that provide incentives for innovation and the success of diverse learners.

States can enact effective incentives by:

> **Adopting performance funding that includes weighting for STEM enrollment, completion and post-completion success.**

State funding represents 51 percent of total higher education operating expenses, with tuition making up the vast majority of the remaining 49 percent (State Higher Education Executive Officers Association 2014). This revenue therefore represents an opportunity to align funding with policy goals in order to incentivize meaningful reform and improve student outcomes. States should ensure that their operating funding allocation systems directly reward student success, particularly for middle-skill STEM programs, degrees and certificates, including rewarding colleges for students' success in Bachelor's programs and the STEM workforce.

Jobs for the Future has identified six principles for effective performance funding systems:

- **Reward both progress and completion.** Establishing an incentive for progress—not just completion—is particularly important to support the academic momentum of community college students, and it encourages colleges to implement support, advising and other strategies that result in greater persistence.
- **Protect the academically and economically vulnerable.** This can also be accomplished in part by rewarding progress, particularly through developmental coursework into credit-bearing courses, so that institutions do not have a disincentive to enroll at-risk students.
- **Make the incentive big enough to change institutional behavior.** States should strike a balance so that the incentive is big enough to have impact but not so dramatic as to generate unwanted risks and political backlash. While states may be inclined to start with performance allocations equal to 1 or 2 percent of total funding, small amounts are unlikely to result in significant, long-term behavioral change.
- **Implement the formula gradually and with predictability.** States should implement new formulas over time, giving institutions the ability to change practices and policies. In addition, limiting the amount any institution can lose in a given year and minimizing large

year-to-year fluctuations will result in greater predictability and avoid negative outcomes.

- **Get buy-in from key stakeholders, including faculty.** Engaging institutional leaders and faculty in the design of the performance-based funding system can be critical for both effectiveness and for gaining political support.
- **Introduce performance-based funding in the context of a strategy to improve the performance and efficiency of higher education.** A performance-based funding plan is more likely to gain traction if it is part and parcel of a clear, strong and forward-looking comprehensive package that addresses many of the other state policies identified in this paper (Altstadt 2012).

Starting in the fiscal year 2013, Massachusetts funds its 15 community colleges through a new formula that is partially determined by each institution's educational outcomes. In addition to a base operating subsidy, each institution's remaining state revenue will be determined: 1) half on student credit hours completed, and 2) half based on performance measures including the number of students that earn degrees or transfer with a certain amount of course credit (Chieppo 2013). The formula includes giving extra credit to the college if their STEM and healthcare-based degrees or transfer credits are completed (Bombardieri 2013).

Ohio's community colleges are now implementing a new outcomes-based funding system (Ohio participates in the STEM Regional Collaboratives) that will reward colleges for course and credential completion as well as transfer outcomes, and includes additional weighting for STEM programs.[35] A core recommendation of the Ohio Higher Education Funding Commission was that, "The funding for community colleges in Ohio should transition from a system that mainly rewards enrollment in classes to one that rewards the completion of classes, certificates and degrees" (Ohio Higher Education Funding Commission 2012). The Commission recommended that by fall 2014—the second year of the new funding system's implementation—no community college funding would be awarded based on enrollment. Sample measures include important milestones such as students earning their first 12, 24, and 36 credit hours, students completing the associate degree, and transfer students completing a Bachelor's degree.[36]

> **Using state innovation funds targeted to STEM program innovation and to successful implementation of STEM career pathways that lead to stable jobs and higher wages.**

With state funding for higher education still scarce following the national recession and cuts in state budgets, implementation of many of the strategies discussed here as well as additional innovative programs, policies and tools for middle-skill STEM success is difficult without dedicated funding. States should consider allocating innovation funds targeted to program redesign and STEM career pathway development.

In Massachusetts, for example, the Vision Project Performance Incentive Fund awards grants for campuses to pursue innovative projects focused on "college participation, college completion, student learning, workforce alignment, preparing citizens and closing achievement gaps."[37] The Fund has grown from $2.5 million to $7.5 million since its launch.

In most states, funding dedicated to innovation must either be carved out of already-tight operating budgets or sought from public or private foundations. For example, the Robin Hood Foundation's College Success Prize will award $5 million for technology solutions that encourage student persistence and graduation at community colleges.[38] Allocating state funds to encourage innovation can be even more powerful because it may leverage other state resources such as base operating funding, build political will for middle-skill STEM reform, and signal the importance of linking funding to program effectiveness and innovation.

> **Establishing STEM scholarships that enable full-time enrollment, address supply/demand challenges and reward persistence toward degree completion.**

College affordability and the perception of affordability remain major barriers to college enrollment for many Americans, and states should develop STEM scholarship programs that encourage students to pursue STEM degrees and careers as one component of a broader college access strategy. In structuring these STEM scholarship programs, states have a valuable opportunity to establish incentives for pathways that lead to better student outcomes, including the ability to enroll full-time and to maximize transfer policies.

For example, Virginia's Two-Year College Transfer Grant Program provides targeted financial assistance that both encourages STEM pathways and rewards completion of an Associate's degree as a step toward earning a Bachelor's degree. Students who complete an Associate's degree with a GPA of 3.0 or above receive $2,000 per year for up to three years to pursue a Bachelor's degree in science, engineering, math, nursing or teaching at any four-year college or university in Virginia (the award has a maximum of $1,000 per year for non-STEM programs).[39]

In New York, the state launched a STEM Incentive Program in 2014 that pays the full cost of tuition for any student in the top 10 percent of their high school class to enroll full-time at a public 2- or 4-year college or university in pursuit of a STEM Associate's or Bachelor's degree. Participating students must work in a STEM field in New York State for five years after graduating, or their scholarship is converted to a loan.[40]

> **Providing tax breaks for STEM graduates who work in-state (or in targeted underserved parts of states) in order to stop the STEM-skill "brain drain."**

Along with financial aid programs that encourage students to pursue STEM careers, states should explore tax breaks and other incentives that retain the STEM workforce in-state and encourage them to pursue additional education and training—building workers' incomes while advancing a state economic development agenda.

Proposed legislation in Ohio exemplifies this strategy. House Bill 405 would provide college graduates with income tax credits for up to 10 years to incentivize STEM workers to remain in Ohio. Annual tax credits would be set at $500 for an Associate's degree, $2,000 for a Bachelor's degree and $3,000 for a Master's degree. Graduates who leave the state within five years would be required to refund any tax credits received.[41]

States may also benefit from more targeted tax break programs that encourage STEM graduates to work in specific underserved regions (e.g., rural or urban communities) that are the focus of economic development efforts to build concentrations of STEM employers.

CONCLUSION

The potential of the Innovation Economy is often portrayed as exacerbating the economic inequalities of American society because of its emphasis on technology, knowledge and highly skilled workers.[42] But it does not have to be that way. The availability of middle-skill STEM jobs—a demand that is only expected to grow in coming years—represents a unique opportunity to prepare Americans for jobs that pay good wages, that do not require a Bachelor's degree, and that in many cases can become a step on a career pathway to higher-skill positions and further education.

Harnessing this potential requires significant reforms in our education and training systems. The nation cannot meet the STEM jobs challenge with our current rates of college attrition, nor can we close the equity gaps that frequently leave students from underrepresented communities behind without significant changes to policies and programs.

States are uniquely positioned to implement comprehensive middle-skill STEM agendas that link students and programs to labor market opportunity, redesign developmental education so that underprepared students truly have a chance, create new pathways that lead to completion, improve the use and transparency of data, and align incentives to these broad policy goals. It is time to build on the innovations already in place in pockets across the country and generate economic growth by leveraging middle-skill STEM opportunities.

ENDNOTES

[1] Federal agencies do not agree on a common definition; the National Science Foundation definition corresponds roughly to jobs requiring a Bachelor's in science or engineering. Conflicting definitions are inconsistent in how they treat blue-collar workers, doctors, and other occupational groups.

[2] See: http://www.aacc.nche.edu/Advocacy/toolkit/Documents/factsheet.pdf

[3] See: http://www.aacc.nche.edu/AboutCC/Documents/Facts14_Data_R3.pdf

[4] Note that most community college students are at least 22-years-old. See: http://www.aacc.nche.edu/AboutCC/Documents/Facts14_Data_R3.pdf

[5] Two excellent sources of new research on what works are the Community College Research Center at Teachers College, Columbia University, and MDRC.

[6] See: www.achievingthedream.org, www.completionbydesign.org, www.acceleratingopportunity.org, www.completecollege.org, and www.ccsse.org

[7] See: http://legacy.kctcs.edu/organization/board/meetings/201306/01_Board/Pres%20Rpt%20to%20Board-ENGAGEMENT-June%202013%20letterhead.pdf

[8] See the Breaking Through Contextualization Tookit, available at http://www.jff.org/publications/breaking-through-practice-guide or http://www.jff.org/sites/default/files/publications/materials/BT_toolkit_June7.pdf

[9] Oklahoma offers an analogous example by working with employers to provide financial incentives and flexibility to workers who are pursuing an Associate's degree. The state's Reach Higher initiative is designed for adults who already have at least 18 hours of college credit.

[10] See: http://scitechmn.org

[11] See http://www.ohiomeansinternships.com and https://www.ohiohighered.org/omic

[12] See: http://www.themanufacturinginstitute.org/~/media/A07730B2A798437D98501E798C2E13AA.ashx

[13] See: http://www.dllr.state.md.us/earn

[14] See: http://www.ct.edu/files/pdfs/12-40-overview.pdf and http://www.ct.edu/initiatives/dev-education

[15] See: http://www.utdanacenter.org/mathways/index.php

[16] See: "Early Results." Accessed February 4, 2013 at http://pathways.carnegiefoundation.org/what-is-happening/2012/early-results and "Positive Changes on Productive Persistence Measures." Accessed February 4, 2013 at http://pathways.carnegiefoundation.org

[17] See also: http://old.vccs.edu/FacultyStaff/ProfessionalDevelopment/DevelopmentalEducation/DevelopmentalEducationInstitute.aspx

[18] See: http://www.successnc.org/initiatives/career-college-promise-0

[19] See: http://www.chattanoogastate.edu/high-school/sails

[20] JFF's Early College High School Initiative reported a median four-year graduation rate in 2010-11 of 93 percent for students at early colleges, compared with 76 percent for the school's broader districts (data from Jobs for the Future's Student Information System). Fifty-six percent of the early college graduates in 2010-11 had earned at least two years of college credit at the same time as their high school diploma.

[21] See: http://www.thecb.state.tx.us/index.cfm?objectid=2C8D18C4-DB8F-5463-3290D5FDEEA68498

[22] See: http://www.governor.ny.gov/press/08072014-public-private-partnership-for-students

[23] See: http://www.governor.ct.gov/malloy/cwp/view.asp?A=4010&Q=542906

[24] See: http://www.fldoe.org/fcs/OSAS/Correspondence/pdf/JA-MemoMetaMajors.pdf

[25] See: http://www.mdc.edu/sai/implementation/communities.aspx

[26] See: http://www.guttman.cuny.edu/academics/firstyearoverview.html and http://www.guttman.cuny.edu/academics/majors/businessadministration/schedule.html

[27] See: http://www.maricopa.edu/alliance

[28] See: http://knowhow2goky.org/kh2t/transfer_policies.php

[29] See: https://www.northcarolina.edu/?q=content/new-college-transfer-options-save-time-and-money

[30] See: https://www2.ed.gov/about/bdscomm/list/completion-metrics.pdf

[31] See: http://www.okhighered.org/studies-reports/employment-outcomes/employrpt-10-2012.pdf and http://smart-college-choices.com

[32] See: http://www2.dataqualitycampaign.org/your-states-progress/10-state-actions?action=one

[33] See: http://www.hawaii.edu/hawaiigradinitiative

[34] See: http://www.vccs.edu/about/where-we-are-going

[35] See: https://www.ohiohighered.org/press/new-performance-based-model-higher-education-ohio

[36] Email from Michael Snider, Project Director with the Ohio Association of Community Colleges, August 2014. See also: National Conference of State Legislatures. "Performance-based Funding for Higher Education." March 5, 2014. http://www.ncsl.org/research/education/performance-funding.aspx

[37] See: http://www.mass.edu/visionproject/pif.asp

[38] See: http://www.robinhood.org/prize

[39] See: http://www.schev.edu/students/factsheetTransferGrant.pdf

[40] See: http://www.hesc.ny.gov/content.nsf/SFC/NYS_Science_Technology_Engineering_and_Mathematics_STEM_Incentive_Program

[41] See: http://www.legislature.state.oh.us/bills.cfm?ID=130_HB_405

[42] See, for example: Acemoglu, Daron. Winter 2003. "Technology and Inequality." *NBER Reporter*.

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TEL 617.728.4446 FAX 617.728.4857 info@jff.org

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