RAND CORPORATION

Research Report

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The Appalachia Partnership Initiative's Investments in K–12 Education and Catalyzing the Community

Reflections from 2014 Through 2017

KEY FINDINGS

- Appalachia Partnership Initiative (API) program administrators reported that 48 percent of K–12 students reached by the programs were low income, 47 percent were girls, and 42 percent attended school in rural communities.
- Strategies to promote financial and programmatic sustainability included maintaining low program costs, finding other revenue streams, writing services into grants, charging for services when possible, and applying for additional funding from other funding sources.
- From October 2014 through December 2017, 2,225 teachers received training by API-funded programs. Challenges in offering teacher professional development included enough time out of the classroom for training, competition for teachers' time among multiple training opportunities, turnover among trained teachers, varying state certification and training recognition regulations, and geographic spread of teachers.
- API K–12 STEM programs collaborated with one another, and the number of local partnerships and partnerships across state lines increased. Development of a well-defined policy agenda, coordination of API funding and activities, and interconnecting program and initiatives across state boundaries within the API region could be useful next steps.

The economy in the tristate Appalachia region of southwestern Pennsylvania, northern West Virginia, and eastern Ohio has long included the production and extraction of energy from fossil and renewable sources. Since 2008, natural gas production in the Appalachian region has grown quickly, with particular growth in 2011, because of the use of hydraulic fracturing and horizontal drilling to extract natural gas from the Marcellus and Utica Shales. In 2018, after an increase of more than 25 percent from the 2015 average levels, Appalachian gas accounted for almost half of total U.S. dry natural

Abbreviations

API	Appalachia Partnership Initiative
CMP	Children's Museum of Pittsburgh
CSC	Carnegie Science Center
IU1	Intermediate Unit 1
PLTW	Project Lead the Way
STEM	science, technology, engineering, and mathematics

gas production (see Box 1; U.S. Energy Information Administration, 2018c).

This growth in energy production has spurred a concomitant increase in demand for hiring workers who are proficient in science, technology, engineering, and mathematics (STEM). Additionally, employers in the region are searching for workers with crosscutting skills—such as problem-solving and teamwork—and who demonstrate skills hybridization, meaning that they have multiple, adaptable skills. It is thus important for the tristate region to have high-quality K–12 STEM education opportunities, as well as policies and programs in place to enable the supply of labor in STEM occupations and career fields to keep pace with evolving demand.[1]

A challenge in the region is that the supply of workers with STEM skills has not kept pace with STEM workforce demand, which limits the region's capacity to benefit from national and global economic advances.[2] The region thus faces a shortage of workers with STEM skills who can be employed in the energy and advanced manufacturing industries. This shortage can be attributed to four issues:

- The region has an aging workforce and a shortage of working-age adults to replace impending retirements.[3]
- There is insufficient awareness among families and K–12 educators about STEM-related postsecondary educational and career opportunities for their children (Campos Research Strategy, 2014).
- There is an inadequate supply of qualified individuals for middle-skilled occupations (requiring high school and some additional formal training) that require STEM skills (Burning Glass Technologies, Council for Adult and Experiential Learning, Allegheny Conference on Community Development, 2016; Accenture, Burning Glass Technologies, and Harvard Business School, 2014; and Gonzalez et al., 2015).
- Veterans and rural residents who could potentially fill these positions remain underemployed (Burning Glass Technologies, Council for Adult and Experiential Learning, Allegheny Conference on Community Development, 2016; Accenture, Burning Glass Technologies, and Harvard Business School, 2014; and Gonzalez et al., 2015).[4]

Recognizing the workforce and education challenges facing the energy and advanced manufacturing industries in the region, the Social Investment Team of the Chevron North American Appalachian Mountain Business Unit launched the API in 2014 and committed to investing $20 million to support K–12 STEM education and STEM workforce-development programs to educate and train local adult workers. The API

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Box 1
Quick Facts: Energy Production in Ohio, Pennsylvania, and West Virginia

- According to recent data, in 2016, Ohio was ranked 11th in total energy production in the United States (2,411 trillion BTU).[5] It ranked fifth in natural gas production in 2017 (1.8 trillion ft^3).[6] Most natural gas is extracted from the Utica Shale; the state produced more than 21 times the natural gas from the Utica Shale in 2017 than in 2012. It ranked 15th in coal production, having produced about 9,500 short tons of coal in 2017.[7] Ohio has a relatively more diverse portfolio of energy production than Pennsylvania and West Virginia. For example, it is the eighth-largest ethanol-producing state in the nation, supplying close to 550 million gallons of ethanol per year.
- According to recent data, as of 2016, Pennsylvania was the second-largest total energy producer in the United States after Texas (at 7,888 trillion BTU).[8] The state was the second-largest natural gas producer in 2017, having produced close to 5.5 trillion ft^3 of natural gas, and accounted for 19 percent of total U.S.-marketed natural gas production in 2017.[9] The bulk of natural gas production comes from the Marcellus Shale. Between 2017 and 2018, Pennsylvania increased permitting and drilling activity with the expansion of a regional pipeline, which is capable of moving natural gas to market centers outside the state.[10] Pennsylvania ranks third in coal production, producing about 49,000 short tons of coal in 2017.[11]
- As of 2016, West Virginia is the fifth-largest energy producer in the nation, generating 4.5 percent of the nation's total (3,785 trillion BTU).[12] West Virginia was the seventh-largest natural gas producer in 2017, generating close to 1.6 trillion ft^3 of natural gas.[13] It is the second-largest coal producer (after Wyoming), with about 93,000 short tons of coal in 2017,[14] which accounted for 11 percent of the total coal production that year.[15]

covers 27 counties in Pennsylvania, West Virginia, and Ohio (see Figure 1). In addition to Chevron Corporation, founding leaders include the Allegheny Conference on Community Development and the Claude Worthington Benedum Foundation. In 2016, the Grable Foundation, and, in 2017, Catalyst Connection joined. Membership among this group, referred to as *API leaders*, is expected to expand over time. The RAND Corporation serves as the external research and analysis lead for the API.

In addition to STEM programmatic investments, API leaders engage in policy discussions and initiatives to catalyze the community to support a skilled talent pool that could become employed in the energy and advanced manufacturing industries. The API consists of an expanding network of partner organizations from the business, foundation, nonprofit, research, and education sectors.

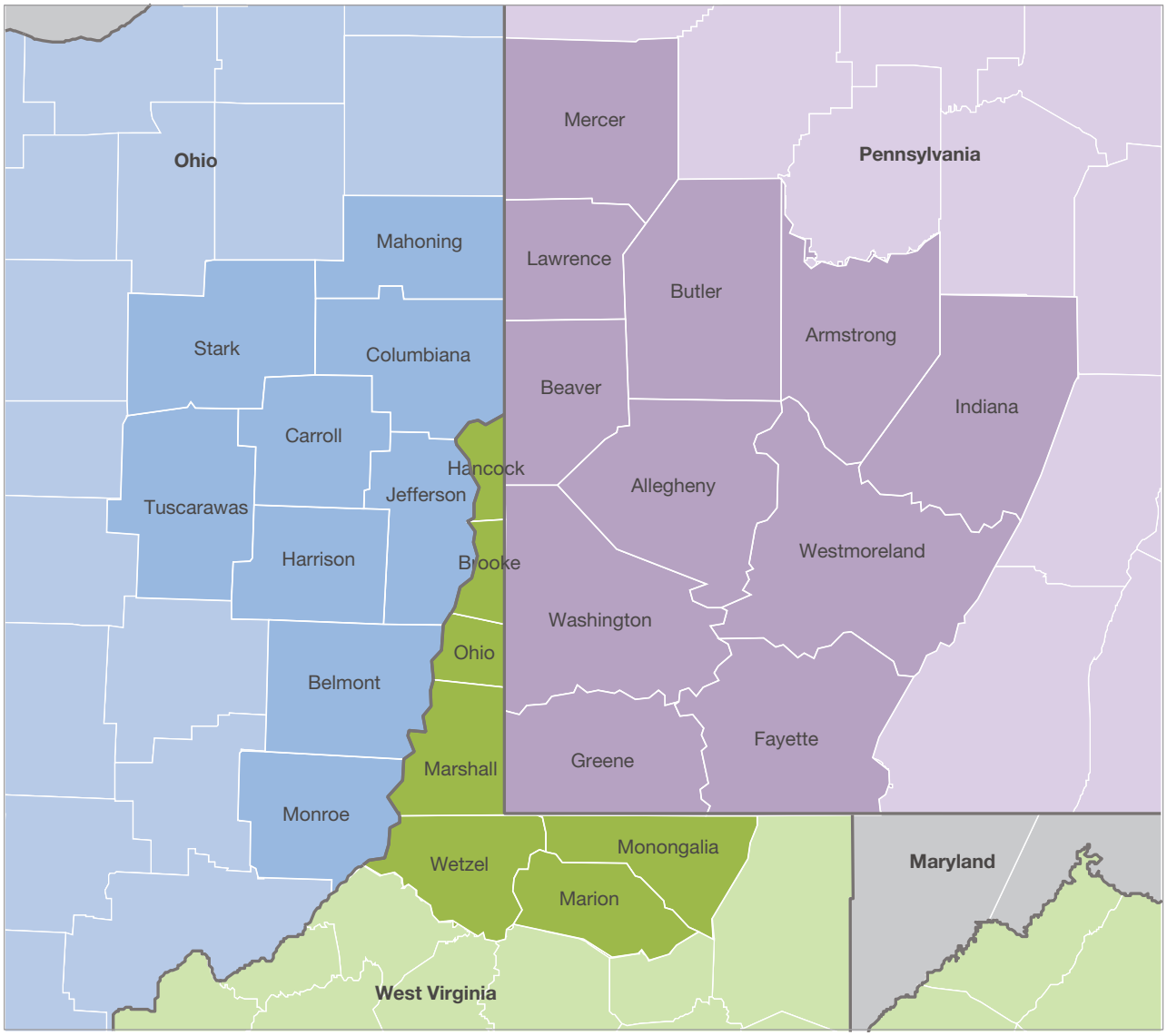
Approach and Objectives of This Report

RAND is conducting an assessment of the API's progress toward its vision and goals, with interim assessments performed annually from 2016 to 2019. A final summary evaluation in 2020 will provide analysis of the impact of API investments in K–12 STEM education, energy and advanced manufacturing workforce development, and community building over the five-year period from October 2014 through July 2019. The first interim assessment analyzed the beginning stage of the API from October 2014 through December 2016 across all of its endeavors (K–12 STEM, workforce development, and catalyzing the community). Key findings and recommendations from the first interim assessment are listed in Box 2.[16]

This report is the second annual assessment, which presents a review of the API's progress from October 2014 through December 2017 toward its vision for K–12 STEM activities and initiatives related to catalyzing the community. The third interim assessment will focus on the API's progress to

FIGURE 1

27 Counties Composing the API Region



SOURCE: Gonzalez, Culbertson, and Nanda, 2017a, p. 3.

meeting its workforce-development goals and vision from October 2014 through December 2018.

We consider four questions in this report:[17]

1. **Strategic alignment:** How did the API K–12 STEM education programs and activities evolve and adapt to meet the API's vision and strategy?
2. **Beneficiaries:** What was the geographic scope of API K–12 STEM education programs, and which beneficiaries did the programs reach?
3. **Implementation:** How were API K–12 STEM education programs implemented? How sustainable were these programs?
4. **Community catalyst:** What steps did API leadership take to catalyze a community of stakeholders to work toward similar goals related to K–12 STEM education?

To answer these questions, we relied on two sources of data:[18]

Box 2
Key Findings and Recommendations from First Interim Assessment of the API (2014–2016)

Findings

- Between 2014 and 2016, the API began to support the acquisition of STEM-related skills among K–12 and adult students; engage industry in workforce development; and enlarge STEM-collaborative networks across 27 counties in the three states.
- API programs incorporated hands-on and project-based instructional models that aimed to improve skills acquisition.
- Programs operated in all 27 counties targeted by the API and had reached more than 70,000 people, mostly through K–12 STEM education opportunities.
- While programs engaged with industry leaders, few workforce programs focused specifically on transitioning workers.
- The API could further its vision for the region by broadening regional awareness of STEM career opportunities.
- The API could further expand STEM teacher training and facilitate collaboration across program, government, university, and funder networks.
- To support the longer-term financial sustainability of programs, the API could further leverage existing networks of STEM education and workforce-development stakeholders; these networks offer opportunities to engage long-lasting sources of support within the region.

Recommendations

- Continue to gauge participants' perceptions and awareness of STEM careers and API programs by implementing a survey.
- Map pathways between K–12 education and middle-skill jobs; career pathways are models that show which skills, degrees, and certifications can lead to specific STEM-related careers and middle-skilled jobs.
- Fill programming gaps, particularly through a coordinated strategy to promote stakeholder awareness of STEM careers, pre-service teacher training, and additional workforce-development programs for dislocated and transitioning workers.
- Strengthen and expand networks of relationships with regional funders, with the API serving as a strategic facilitator between funders and programs.
- Determine priority challenges for the API to focus on solving, as a regional analysis of the most significant challenges facing K–12 STEM education and workforce development is missing.
- Sponsor tristate meetings for K–12 STEM education, similar to the Tristate Shale Summit that API leaders cosponsored.
- Focus on deepening connections among API workforce-development programs.
- Craft a broad strategy for policy engagement to support tristate education and workforce development; now that the API has established a track record, it is well positioned to develop and advocate for strategic policy goals at the state-, city-, or district-level for K–12 STEM education and workforce development.

Any overall judgment of API effectiveness in achieving its vision would be premature. Therefore, this early-stage assessment measures progress toward the vision and offers suggestions for improvements or indications of where gaps may lie.

1. **Quantitative indicators.** In a set of meetings in July 2015, we worked with API leaders to create a set of indicators that aimed to measure API programs' activities, services delivered, and outcome goals related to programming. Every six months, we sent data-collection templates to program administrators; program administrators completed the templates to the best of their ability and with quantitative indicators. For this report, we used information from August 2014 to December 2017 related to beneficiaries served, networks developed by the program, professional development opportunities made available, and community and activities that built awareness of K–12 STEM careers and of the program itself.[19]
2. **Interviews.** In July 2018, we interviewed API program administrators and inquired about program activities and mission, beneficiaries, facilitators and barriers to implementation, sustainability, funding or in-kind support, and reported effectiveness to date.[20] In August 2018, we interviewed API leaders to inquire about the role each API leader had taken to date on serving as a community catalyst, the nature of their community relationships, and connections. We analyzed interview data by organizing program administrators' responses by research question and aggregating cross-program similarities and differences.

Using the quantitative indicators and interview data, we produced network-analysis diagrams to analyze relationships among API programs, funders, and partners.[21]

There are three important limitations to this assessment:

- Any overall judgment of API effectiveness in achieving its vision would be premature. Therefore, this early-stage assessment measures progress toward the vision and offers suggestions for improvements or indications of where gaps may lie.
- This report evaluates the API *portfolio*, not *individual programs*. It focuses on how programs collectively promote the API's goals and where gaps exist.
- This analysis incorporates data from multiple sources, some of which were self-reported or incomplete because of the nascence of the API programs and their data-collection efforts. Importantly, the interview data program administrators and API leaders that we used for our findings were self-reported and based on perceptions. Thus, our findings about the extent to which programs' goals align with the API's mission and goals or on the extent to which programs have evolved or changed through time are based on the impressions of interviewees and not from objective sources.

How Did API K–12 STEM Education Programs Evolve and Adapt to Meet the API Vision and Strategy?

The vision of the API is to promote "a sustainable regional energy and manufacturing education and employment ecosystem that supports the region's broader economic development" (Gonzalez, Culbertson, and Nanda, 2017a, p. 3). The API does this by investing in innovative and strategically selected K–12 STEM education and workforce-development programs. We documented the API's strategy and its programs' activities, direction, or partnerships—and any modifications or changes in those since funding started in 2014—to ascertain the extent to which sponsored programs are supporting the API in meeting its vision.

While It Is Still Too Early to Assess Student Outcomes, API K–12 STEM Education Programs Were Strategically Aligned with the API Logic Model

From March through July 2015, API leaders developed its vision and a supportive strategic logic model (described more fully in Gonzalez, Culbertson, and Nanda, 2017a) with RAND facilitation. The model maps the types of programs to fund and desired outputs and outcomes, as well as a community-wide long-term vision, with accompanying goals and indicators to measure progress of the API.[22] According to this logic model, the API aims to achieve its vision by

- promoting long-term, sustainable strategies to build the capacity of local workers for jobs in the energy and advanced manufacturing sectors
- creating new STEM-related economic and educational opportunities
- building strong integrative relationships among the region's corporate, nonprofit, and community leaders.

Using this overarching vision as a guide, the API then created specific logic models for its investments in

- K–12 STEM education programs (Figure 2)
- workforce-development programs (i.e., initiatives that expand and maintain a pool of local workers qualified for jobs in the energy and advanced manufacturing sectors in the Marcellus and Utica Shale region)[23]
- Efforts to catalyze a community of stakeholders to collaborate on issues related to STEM education and the workforce and to advocate for policies that support K–12 STEM education and workforce development (discussed later in this report).

Figure 2 illustrates the logic model for K–12 STEM education programs in which the API invests. Moving from left to right in the figure, the vision of the API is for funded K–12 programs to produce among program participants four outputs: **awareness** about STEM career opportunities, the **acquisition of skills** important in a STEM career (such as soft, technical, and performance skills), **professional development** among teachers and career counselors or coaches participating in the program, and **networks** between students and employers in STEM careers.

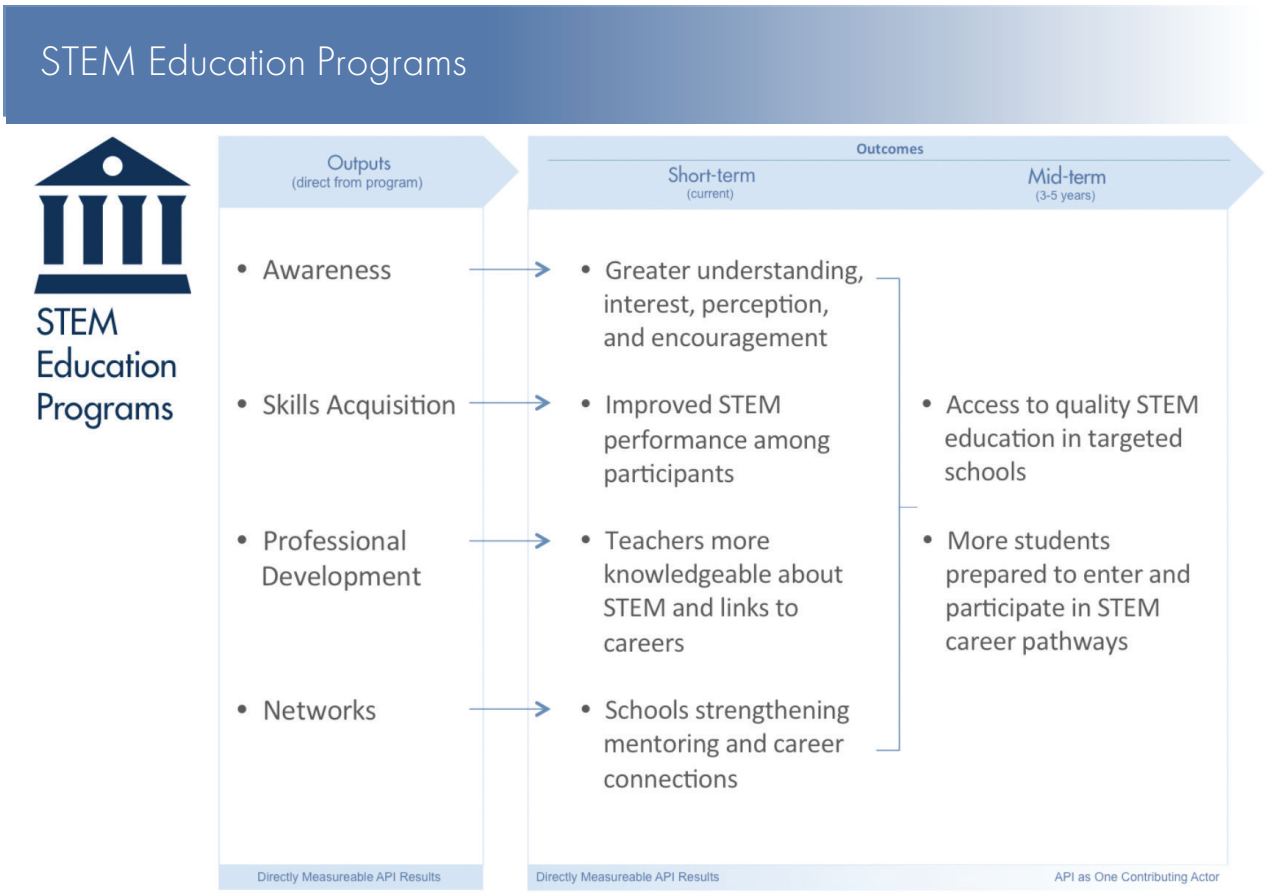
These outputs are then expected to lead to the listed short- and long-term outcomes. In summer 2015, API workshop participants developed a set of corresponding theories of action for K–12 STEM education investments (Box 3).

As of December 2017, the API sponsored 19 programs (relating to both K–12 STEM education and workforce development) under 11 grantees in the 27 designated counties across the tristate region (Table 1). Seven grantees included K–12 STEM programming, which are described in this report: Carnegie Science Center (CSC), Catalyst Connections, Central Greene School District, Children's Museum of Pittsburgh (CMP), Education Alliance, Intermediate Unit One (IU1), and Project Lead the Way (PLTW). Programs for K–12 students ranged from one-day maker events to one-year learning programs to STEM teacher professional development.[24]

API leaders selected these programs and initiatives to target increasing educational preparedness for STEM jobs in the energy and advanced manufacturing sectors and in alignment with the desired outputs for API investments in K–12 STEM education: awareness, skills acquisition,

FIGURE 2

K–12 STEM Education Logic Model



Box 3
Theories of Action for the K–12 STEM Education Logic Model

- **Awareness.** If students, parents, educators, and business leaders are aware of and understand the value of STEM skills and knowledge, then more students will pursue STEM career pathways.
- **Skills acquisition.** If K–12 students acquire defined practical STEM skills and knowledge, then they will be prepared for STEM career pathways.
- **Professional development.** If K–12 teachers undertake defined practical STEM professional development, then students will have improved STEM education outcomes.
- **Networks.** If secondary school leaders and guidance counselors develop STEM job-placement and postsecondary networks (to provide students information about STEM job opportunities and connecting students directly to opportunities), then more students will pursue STEM career pathways.

professional development, and networks. Table 1 also lists which K–12 STEM education programs target each of these desired outputs. All of the programs addressed awareness of students, parents, educators, or business leaders about STEM skills, knowledge, and careers in some way. Many, but not all, programs involved skills acquisition (viewed here as consistent and repeated exposure to teaching about STEM skills, as opposed to single events that were more targeted toward awareness). Most programs involved

TABLE 1

API K–12 STEM Education Programs, Logic Model Outputs Pursued, and Program Evolution (2014–2017)

Grantee	Program Description	Outputs Pursued	Program Evolution
Intermediate Unit 1 (IU1)	• **Fab Lab** is a digital fabrication laboratory that provides K–12 students and adults a platform for hands-on STEM learning experiences. Chevron funded both a stationary and a mobile Fab Lab at IU1. The program covers areas in Washington, Fayette, and Greene Counties.	• Awareness • Skills acquisition • Professional development	• IU1 program leaders viewed the Fab Lab setting as effective with students with mental health challenges and special education students and then developed a specialized curriculum for these student populations. They also trained social workers, who provide group and individual therapy sessions during Fab Lab time.
Children's Museum of Pittsburgh (CMP)	• **Explore Making** is a hands-on learning program designed to increase interest in making and creating among first-grade students. • It includes 32 elementary schools in Fayette, Greene, and Washington Counties of Southwestern Pennsylvania and Marshall County of West Virginia. • The program is a professional development **Maker Boot Camp** for the teachers from the 32 Explore Making schools. • CMP hosted a **Maker Faire** (licensed by Maker Media) in Pittsburgh to exhibit accomplishments of local makers.	• Awareness • Professional development • Networks	• To improve accessibility to teachers, the program moved the Maker Boot Camp teacher professional development to schools and shortened the length from four days to one day. • In 2019, CMP will host its own Maker Festival instead of Maker Media's Maker Faire. The Maker Festival will focus on engineering and construction building instead of general making—matching the region's workforce demands. CMP is partnering with the Rube Goldberg Foundation from New York for this event.
Carnegie Science Center (CSC): Chevron Center for STEM Education and career development	• The **Student Energy Summit** is an annual two-day event involving workshops and projects for regional middle and high school students that introduces topics related to energy use and consumption. • The **Grand Slam Science, On the Road** teaches regional K–8 students physics through baseball. A session at a school includes an assembly show and hands-on experience. • Chevron funded a stationary **Fab Lab** at CSC and a mobile CSC Fab Lab that travels throughout sites in southwest Pennsylvania.	• Awareness • Skills acquisition • Networks	• Grand Slam continuing with API funding.
Education Alliance	• Education Alliance coordinates the **STEM Network Schools** (eight West Virginia schools) in developing their own STEM programs for middle and high school students using CSC STEM Excellence Pathway as a guide. Chevron funds two schools.	• Awareness • Skills acquisition • Professional development • Networks	• The STEM Network Schools passed out of the development phase of their school-specific STEM education programs and have now implemented their planned programs. They have expanded their partnerships, trained more teachers, and engaged more students.
Project Lead the Way (PLTW)	• **PLTW** provides K–12 STEM curricula to elementary, middle, and high schools throughout the United States. Chevron funds PLTW Gateway (grades 6–8) and engineering programs (grades 9–12) in Pennsylvania, Ohio, and West Virginia schools within the API region.	• Awareness • Skills acquisition	• Six additional schools in the API region adopted PLTW programs. • Initially, the API funded the PLTW Gateway and high school engineering programs. The API-funded schools now also include PLTW Launch for grades K–5.

TABLE 1—CONTINUED

Grantee	Program Description	Outputs Pursued	Program Evolution
Central Greene School District	• The Natural Resources Course at Central Greene School District is a **one-year course** for high school students to prepare them for further education or occupations within the natural gas industry, resulting in industry-based certifications.	• Awareness • Skills acquisition • Networks	• Increased the number of partnerships with employers to allow for more job opportunities for graduating students. • Partnered with a local mine training center for the commercial driver's license certification. • Provided continuous professional development for course teachers to create a well-rounded program.
Catalyst Connection	• The **Middle School Student Video Contest** matched manufacturers with student teams to create publicly available videos about "what makes manufacturing cool." • **Adventures in Technology** matches middle and high school students with local industry to fund research projects. • The **Manufacturing Career Exploration Program** with Girl Scouts involves an advisory committee of women in manufacturing to develop initiatives to attract girls in STEM. • **Pathways to Apprenticeship** targets awareness of career and apprenticeship opportunities in manufacturing among teachers, parents, educators, and administrators. • Catalyst Connection collaborated with **ASSET STEM** education to develop a teacher professional development workshop for project-based learning. Chevron funded 100 teachers in the workshop. • Catalyst Connection programs cover counties in west Pennsylvania, northwest Pennsylvania, the northern panhandle of West Virginia, and Pittsburgh.	• Awareness • Professional development • Networks	• The Middle School Student Video Contest has expanded from a regional competition to a statewide initiative, with plans to expand from 10 to 20 schools. • The programs have increased sponsorship and employer engagement.

SOURCE: Interviews with program administrators, July 2018.

teacher professional development efforts. The programs that were for the older students involved networks, linking students to employers.

We also found that while many programs' activities and reported outputs aligned with the API logic model's framework, program administrators with whom we spoke did not express much awareness of how their efforts aligned with the API's goals or other API grantees' activities and would have appreciated a stronger community through the API. Having a stronger connection between programs and the API could propel both to better meet the economic development needs of the region.

While our research reviewed program goals, outputs pursued, and alignment to the logical model, it did not assess the extent to which programs were achieving the desired short-term outcomes (i.e., greater understanding, interest, perception, and encouragement; improved STEM performance among participants; teachers gaining knowledge of STEM and links to careers; and schools strengthening mentoring and career connections) and mid-term outcomes (access to quality STEM education in targeted schools and more students prepared to enter and participate in STEM career pathways). This is for several reasons. First, achieving these results would likely take several more years. Second, particular school and student achievement data that could be used to assess these questions were not available for this report. Third, several of these questions would require additional survey data from

teachers, which was not part of the scope of this report.

Programs Progressed from Planning to Implementation, Evolved Based on Needs and Experience, and Expanded in Size and Partnerships

Our interviews with program administrators revealed that, since receiving API sponsorship, programs have progressed from planning to implementation and have been continually evolving (adapting programming and activities) and expanding partnerships. Table 1 describes API K–12 STEM education program evolution.

According to our interviews with programs administrators, the eight Education Alliance STEM Network middle and high schools, guided by the CSC STEM Excellence Pathways, progressed from the development and planning phase of their specific STEM programs to their full implementation phases.

Programs evolved based on experience and to meet perceived needs. IU1 expanded Fab Lab programming to include special education students, developing a specialized curriculum for them. CMP modified their Maker Boot Camp professional development to provide a shorter version within schools (instead of at CMP) and developed its own Maker Festival instead of the Maker Media–licensed Maker Faire in order to enable a stronger focus on the region's industries and potential career paths. Similarly, Catalyst Connection and the Central Greene School District continued to expand on their API-funded programs that improve awareness of and connect students to opportunities within the local manufacturing and natural gas industries, respectively.

Five programs (IU1, Education Alliance, PLTW, Central Greene School District, Catalyst Connection) expanded in size and in the number of partnerships they undertook within local areas and across state borders since API sponsorship started in 2014. For example, IU1 provided professional development resources and consultation for implementing Fab Labs in more schools in the intermediate district's catchment area, including some West Virginia schools; Catalyst Connection expanded Middle School Student Video Contest eligibility from the southwestern Pennsylvania region to a statewide competition and, at the time of the writing of this report, had started expanding other program activities from Pennsylvania to West Virginia; and Education Alliance's STEM Network Schools served as models for other STEM programs implemented by the West Virginia State Department of Education. The number of API partnerships with universities has also increased since the last report (in 2017), although programs largely collaborate with local universities instead of across state lines.

While interviewees noted that partnerships were important to broadening the scale and potentially the scope of programming and reach to beneficiaries, program administrators with whom we spoke noted that there are important gaps and unrealized opportunities related to coordination among multiple partners. Specifically, they noted that there is no big-picture view of the STEM career and technical education "pipeline" that could help grantees identify points at which students are most likely to be delayed—or even fall out of—the STEM system, or points at which education institutions struggle to meet student needs. Moreover, the region does not have a holistic, tristate, or regional conceptualization of career pathways that map the high school coursework, badges, credentials, or skills that a student could obtain from grantees' programs for entry into postsecondary education, training programs, or middle-skill entry-level positions.

What Was the Geographic Scope of API K–12 STEM Education Programs, and Which Beneficiaries Did the Programs Reach?

This section documents where API-sponsored K–12 STEM programs were located across its 27-county API footprint, the number of students in grades K-12 participating in the programs by gender (girls or boys), and the number of students who lived in rural, suburban, and urban areas within the 27 counties as of 2017. We relied on information from interviews with program administrators and the quantitative indicators administrators supplied. API leadership

recognizes that its programs alone cannot feasibly reach all individuals across the entire 27-county footprint. Thus, the snapshot of beneficiaries reported here is intended to inform API leaders on whether sponsored programs are reaching intended subgroup populations and, if not, which specific regions might have gaps in programming or opportunities.

It is important to note that not all program administrators were able to provide the number or description of direct beneficiaries reached for all years we collected data. Thus, there might be gaps in our reporting of students' gender and whether the students lived or went to school in a rural, urban, or suburban county. The inconsistency in data limits our ability to fully document the geographic scope and number of beneficiaries touched by the API. For this reason, we do not report the number of beneficiaries by program, and we clearly note in each figure which program provided us with data at which points in time. Furthermore, we asked grantee administrators to report on those who participated in the programs (i.e., *direct* beneficiaries). Thus, we acknowledge that students or other stakeholders who were touched by the program indirectly were not reported, producing a possible undercount of beneficiaries. Including the number of *indirect* beneficiaries would have been difficult for program administrators to estimate and thus produced uncertainties about the quality of the data.

API-Sponsored K–12 STEM Programs Targeted a Wide Range of Students

API leaders allowed flexibility in which student age or grade ranges (within the K–12 programs) that funded programs were to reach. As noted in Table 2, some programs, such as IU1's Fab Lab and PLTW, focus on school-age populations and are provided to students at specific schools. In contrast, CMP is museum based and reaches broad audiences of children and adults, which makes it difficult to

TABLE 2
API K–12 STEM Programs' Intended Beneficiaries (2017)

Grantee	Program	Intended Beneficiaries
IU1	Fab Lab	K–12 students and educators, adults (through adult education programs), community members, organizations
Children's Museum of Pittsburgh	Explore Making	First grade students and their teachers
	Maker Boot Camp	Teachers
	Maker Faire	Available to public
Carnegie Science Center	Student Energy Summit	Middle school and high school students
	Grand Slam Science, On the Road	K–8 students
	Fab Lab	K–12 students
Education Alliance	STEM Network Schools	Middle school (eventually expanded to high school students)
Project Lead the Way		K–12 students and educators (as an organization, recently focusing more on girls and women and underserved populations)
Central Greene School District	Natural Resources Course	11th and 12th grade high school students (planning to provide classes for adults in the future as well)
Catalyst Connection	Middle School Student Video Contest	Middle school students
	Adventures in Technology	Middle school and high school students
	Manufacturing Career Exploration Program	Girl Scouts
	Pathways to Apprenticeship	Educators, parents, and administrators

SOURCE: Interviews with program administrators, July 2018.

document the genders of the beneficiaries or counties in which participants live.

Figure 3 illustrates the number of students that the API K–12 STEM programs reached in the first year of the API (October 2014–July 2015), compared with the subsequent academic years (August 2015–July 2016 and August 2016–July 2017) and the first semester of 2017 (August 2017–December 2017). Each year is a snapshot of participation, so it may include students who participated in the previous year(s) or who are new to a program; many programs are not able to distinguish between the two types of students in their data. Further, as noted earlier, some programs were not able to provide data for each period.

Figure 3 shows that, in Years 2 and 3, almost 40,000 youth in the 27 counties had participated in the API K–12 STEM programs that reported data (39,903 in Year 2 and 39,987 in Year 3), which was approximately 15,000 more total students than the number of total students participating in Year 1 (26,489 students). Note that these counts could include repeat students, so we are not able to determine the overall number of *individual* students participating in the programs.

API Programs Reached Lower-Income Students, Girls, and Students in Rural Communities

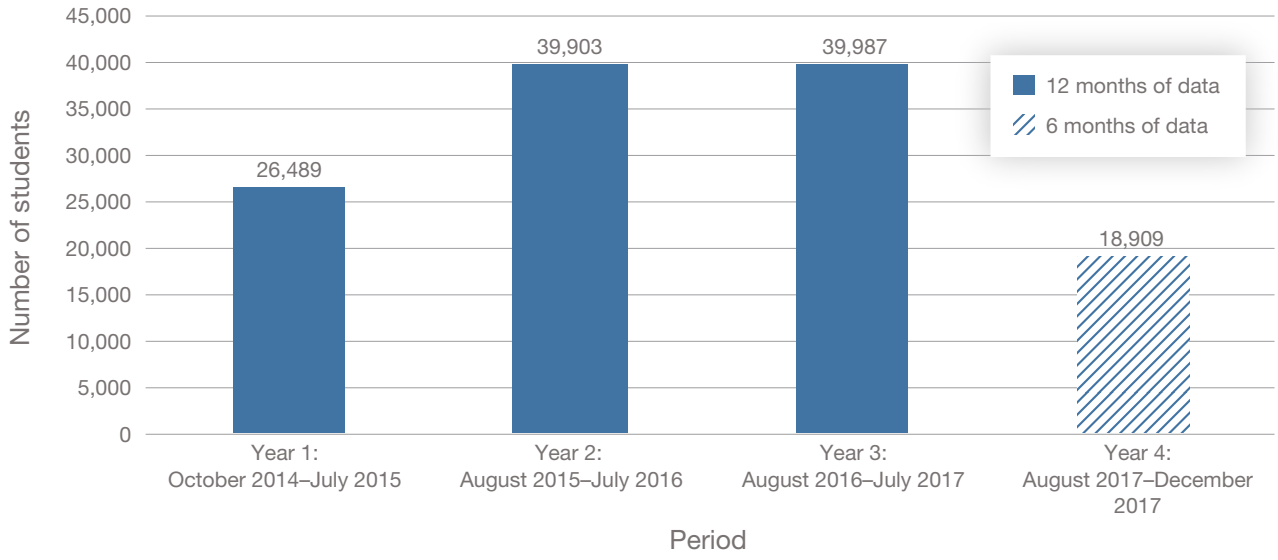
From October 2014 through December 2017, program administrators reported that 48 percent of the youth served by the programs were lower income (based on their estimates or determinations of family income levels) and 47 percent were girls. Further, API-funded programs had reached 81 schools in that period. Although most API K–12 STEM programs—such as the museum-based programs CMP and CSC—were not able to determine where a participant lived or attended school, of the programs that were able to provide us with the information, 42 percent of their participants lived in or attended school in rural school districts and communities. Figure 4 illustrates these demographic indicators.

API Programs Were Heavily Represented in Pennsylvania and West Virginia and Lightly Represented in Ohio

Figure 5 explores in more depth the geographic reach of API K–12 STEM programs. It provides a snapshot of the number of K–12 API programs with

FIGURE 3

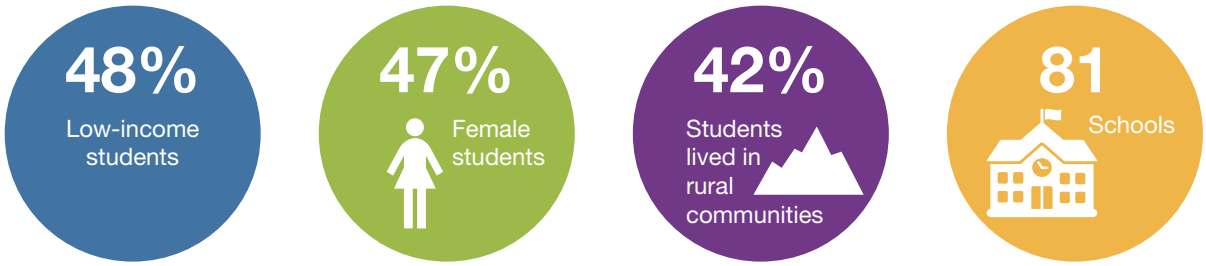
Total Number of K–12 Students Reached by API Programs (2014–2017)



SOURCE: Quantitative indicators provided by grantee administrators.

NOTES: Not all grantees provided data in all years. Year 1 does not include Catalyst Connection, Education Alliance, or IU1; Year 2 does not include Catalyst Connection or CMP; Year 3 does not include IU1 or CSC's Student Energy Summit; Year 4 covers only a six-month period (indicated with a striped bar) and does not include CMP or PLTW (they provide data on numbers of student participants in July of each year, which is outside the Year 4 calendar year period).

FIGURE 4
Student and School Demographics Indicators)



SOURCE: Quantitative indicators provided by grantee administrators.

a geographic reach in a particular county in 2017, compared with the number of school-age children in that county in 2016. As a comparison, the first interim assessment report (Gonzalez, Culbertson, and Nanda, 2017a) provided a snapshot of the number of K–12 API programs in each county in 2015, which includes the number of school-age children in that county in 2014. We can compare these two figures to determine whether the geographic reach of K–12 API programs has changed and whether API K–12 STEM programming is reaching all countries across the 27-county footprint.

As shown in Figure 5, API programs were available in all 27 API counties. Although there appeared to be geographic parity, a closer look revealed that most API-funded programs were available in southwestern Pennsylvania, with a concentration of programs in Allegheny County, where there was also the largest number of public schools and school-age children (ages 3–17). Results have remained similar since last reported in the first interim assessment: In sum, there was not much of a change in the geographic reach of the API in the two periods.

How Were API K–12 STEM Education Programs Implemented, and How Sustainable Were These Programs?

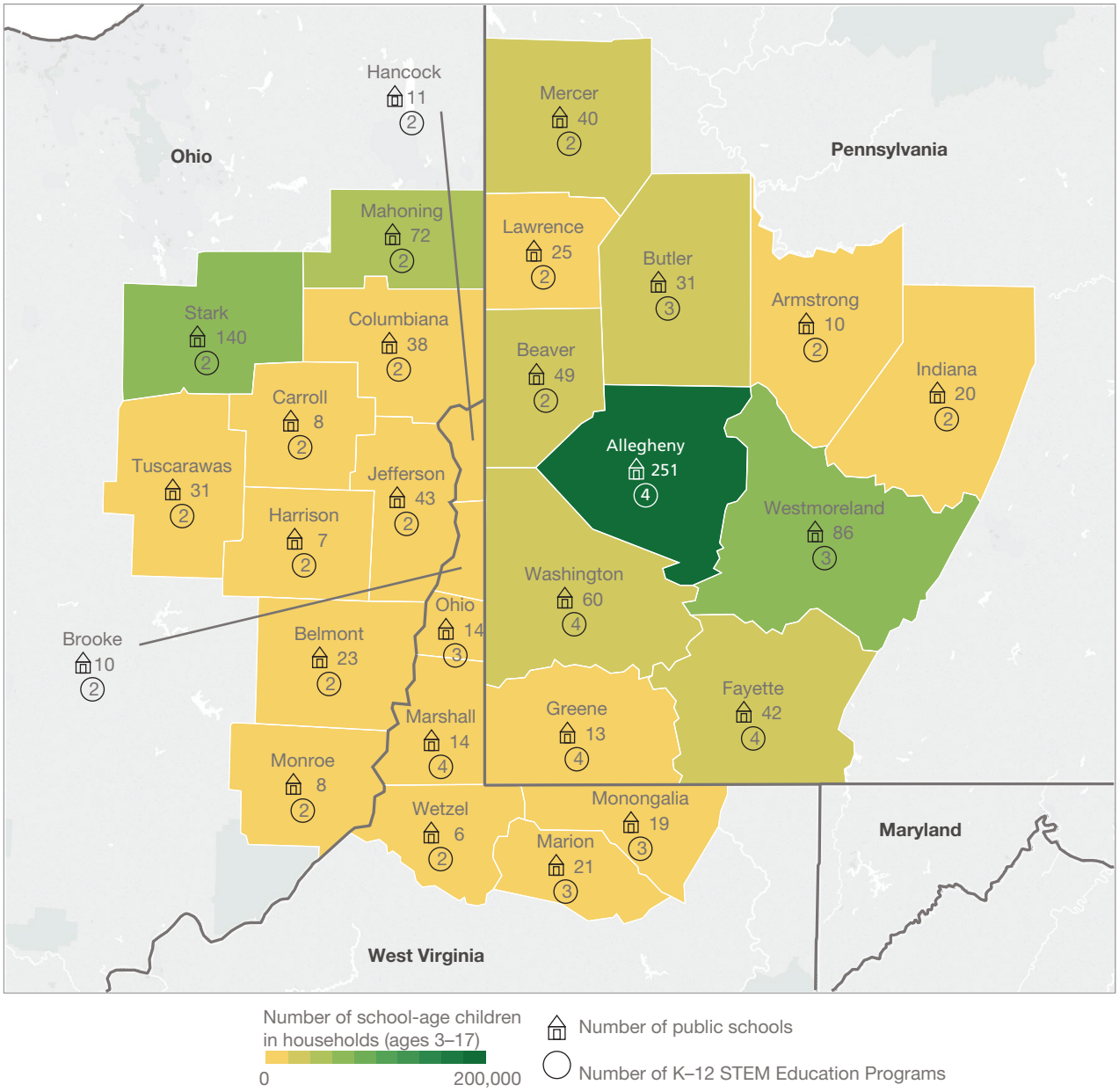
In our interviews, program administrators described several considerations for implementation: the importance of buy-in from participating school leadership, teachers, and students; managing geographic distance, time, and resource availability to make programs more accessible; staff turnover and shortages; and varying revenue streams to maintain sustainability of the programs. These matters were taken into account by interviewees when they noted the ways in which their programs adapted their implementation strategies by finding targeted approaches to addressing gaps in school, student, and employer resources and developing committed leadership to implement effective programs. We discuss interviewees' perspectives on implementation and sustainability in the next section.

Programs Adapted Implementation Approaches to Address Challenges and Maintain a Consistent Vision

Program administrators emphasized adaptation as a key strategy to address a variety of challenges. Flexibility promoted buy-in from participating school leaders and teachers by allowing them to address the needs of their student populations. Specifically, administrators overseeing programs that introduced new curricula within schools (PLTW, Education Alliance, and IU1) found that they obtained more buy-in from participating schools when they provided structure and guidance for developing STEM education programs while allowing teachers to tailor the specifics of the class curriculum. One program administrator mentioned how each participating school developed specialized teacher training, allowing variation in implementation while ensuring that schools worked toward the same goal of improving STEM education. Several program leaders mentioned difficulty in attracting teachers for their specialized teacher training because of distance to site, time commitment, competition in

FIGURE 5

Geographic Distribution of K–12 STEM Programs, by County in the API Region (2017)



SOURCES: Number of school-age children is from the American Community Survey 2013–2017 five-year estimates; number of public schools in Ohio is from Great Schools (U.S. Census Bureau, undated); number of public schools in Pennsylvania is the Pennsylvania Department of Education, undated; number of public schools in West Virginia is from West Virginia Department of Education, undated. Figure from Gonzalez, Culbertson, and Nanda, 2017a.

the marketplace for other types of teacher training, and lack of perceived value in project-based learning. They addressed this by adapting the length and location of the training and taking steps to increase the name recognition of their programs among teachers, leading to increased teacher attendance.

Programs Addressed Gaps in School, Student, and Employer Resources

In our interviews, program administrators highlighted some ways in which they aimed to address resource gaps in various ways among participating schools and students:

- CMP reported that some schools were unable to send their students to the site because of the long distance and corresponding transportation costs. The program now covers lunch and the cost of transportation by bus and has seen a corresponding increase in student attendance.
- Education Alliance assisted under-resourced schools that were struggling with implementing a new STEM education program in getting access to Americorps Vista volunteers for "extra set of hands, eyes, ears and help."
- Catalyst Connection aimed to facilitate companies taking students as apprentices by assisting employers with the necessary paperwork, development of apprenticeship programs, and connecting employers with trainers. IU1's leaders emphasized flexibility in taking on multiple roles and additional training as needed.

Programs Used Various Strategies to Promote Financial and Programmatic Sustainability, Although Administrators Viewed Some Programs as Not Sustainable Without Current Funding Sources

Program administrators described strategies to enable sustainability if their current funding streams were to change. Sustainability strategies included maintaining low program costs, finding other revenue streams, writing services into grants, charging for services when possible, and applying for additional funding from other funding sources. Some programs, however, believed they would not be able to continue if their current funding stopped unless they found another source of funding. As one program leader explained, "Without Chevron funding, most schools couldn't come, [particularly] targeted schools where income isn't high. Schools would need funding."

Several program administrators reported that, from their perspective and observations, staff shortages and turnover were obstacles to program sustainability. As one program administrator described, "Schools with turnover really struggled. They could excel one year, and then the next year start at zero." One program leader believed that the process of implementation at the school level led to sustainability, as the process gave administrators and educators new knowledge, and new policies were embedded in the school as a result:

> We designed the program so that the schools would create their own sustainability programs. It is about sustaining at the local school level. They will need money for supplies. But mostly we asked them to make high-level shifts, different classes, models, to offer STEM education, partnerships, leveraged resources—these will allow them to be sustainable. Continued funding is important but not necessary for them to continue what they are doing.

Committed leadership was also important to sustainability, according to program leadership. For example, IU1 hired a full-time teacher to train other teachers in its specific curricula and equipment, and its program leaders met at least monthly and sometimes weekly to strategize next steps. As one program leader noted:

> One of the biggest takeaways is that, in order to be successful, there has to be leadership commitment. If there is no commitment from [the] school principal and district, then it creates hurdles, and it is difficult for schools to make changes.

Teacher Professional Development Was a Key Aspect of API Investment, with Training Offered in Informal Education, Project-Based Education, Collaboration with Businesses, and Implementing STEM Curricula

Between the start of Chevron and API funding in October 2014 and December 2017, 2,225 teachers have received training by API-funded programs (see Figure 6). Training programs offered by API programs varied widely in training hours, from several hours to a full week. The programs that noted an increase in the number of teachers during this period were PLTW (K–12) and Education Alliance (grades 6–8); programs that mentioned strategies to attract more teachers for training were the CMP

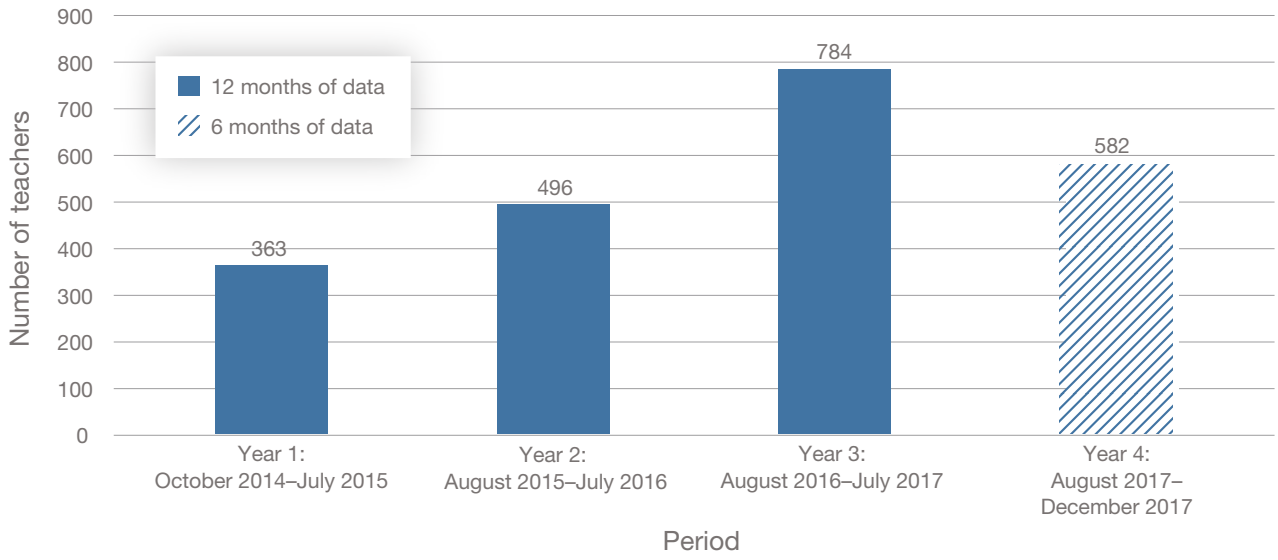
(with programs for first graders) and Catalyst Connection (K–12).

Teacher professional development content varied across programs based on program needs and available resources (see Table 3). Programs emphasized project-based learning that would provide teachers with the skills needed to facilitate open-ended activities for students. Many programs focused on subject-specific skills, such as electronics, machines, or programming.

Program administrators believed that the connections teachers made, both with one another and with industry, were an important aspect of professional development, in addition to the skills they learned. Some programs provided joint professional development for teachers and staff

FIGURE 6

Number of Teachers Trained by API Programs (2014–2017)



SOURCE: Quantitative indicators provided by grantee administrators.

NOTES: Not all grantees provided data in all years. Year 1 does not include Catalyst Connection, Education Alliance, or IU1; Year 2 does not include Catalyst Connection or CMP; Year 3 does not include IU1 or CMP; and Year 4 covers only a six-month period (indicated with a striped bar) and does not include CMP or PLTW (they provide data on numbers of student participants annually in July). CSC does not offer any teacher training, so they did not need to provide data.

TABLE 3

Professional Development Approaches of API Programs

Grantee	Professional Development Model in K–12 STEM Education
Carnegie Science Center	Train teachers in informal STEM education through Fab Labs and Carnegie STEM Excellence Pathway.
Children's Museum of Pittsburgh	Train teachers to blend informal education and formal education, conduct an Educator Boot Camp, work with schools on professional development.
Education Alliance	Collaborate with schools to develop individual school long-term STEM education plans (called the STEM School Showcase), provide technical assistance to schools to implement plans, and help schools partner with local businesses.
IU1 Fab Lab	Train teachers in new approaches, host ongoing professional development meetings and conferences for local educational organizations, provide consultation to other schools, and offer training to community members on Fab Lab equipment.
Project Lead the Way	Provide in-service teacher training for PLTW teachers in curriculum and develop preservice teacher training with teacher colleges.

SOURCE: Interviews with grantee administrators, July 2018.

that engaged teachers in activities to build capacity at the school level: Teachers and administrators collaborated on school transformations as a joint process and conducted frequent team meetings to strategize direction within the school. One program administrator reflected: "The teacher professional development looks different from school to school, but the piece that was consistent was that everyone was expanding on those schools' knowledge and capabilities to teach these materials." Programs also used teacher professional development as an opportunity to help teachers engage with industry, businesses, and employers to improve teacher understanding of STEM career pathways and jobs.

Programs Faced Challenges Offering Teacher Training and Adapted Their Approaches

Administrators described several key challenges in offering teacher professional development. These included teachers having enough time out of the classroom for training, competition for teachers' time for professional development among multiple possible training opportunities in the region, winter weather conditions in recent years that made schedules unpredictable, varying state certification and training recognition regulations, geographic spread of teachers, and turnover among trained teachers leading to the need to repeat the same professional development with new teachers. To address these challenges, programs tried various approaches. One program shortened the time required for the training and offered training at schools, rather than at the program site, which made the training more accessible to teachers who lived farther away. Another program recognized that teachers preferred programs for which they receive a state-recognized certificate, so it provided this. Several programs trained teachers from the same school together, focusing on the school as a system, as it reduced the knowledge loss when a single trained teacher moved on to another position. At the same time, we note that the turnover of trained teachers, viewed as a challenge by individual programs, may also be beneficial for the regional educational system as a whole. Other schools and programs that hired these trained teachers received the benefits of their training and experience.

What Steps Did API Leadership Take to Catalyze a Community of Stakeholders to Work Toward Similar Goals Related to K–12 STEM Education?

Figure 7 illustrates the logic model for efforts to catalyze the community of interested stakeholders. Moving from left to right in the figure, the vision of the API is for its leadership and programs to pursue four outputs: contributions of resources; policy advocacy to improve K–12 STEM education and workforce development; community involvement among educators, businesses, media, and others; and networks with industry associations and government agencies. Theories of action for API community catalyst efforts are listed in Box 4.

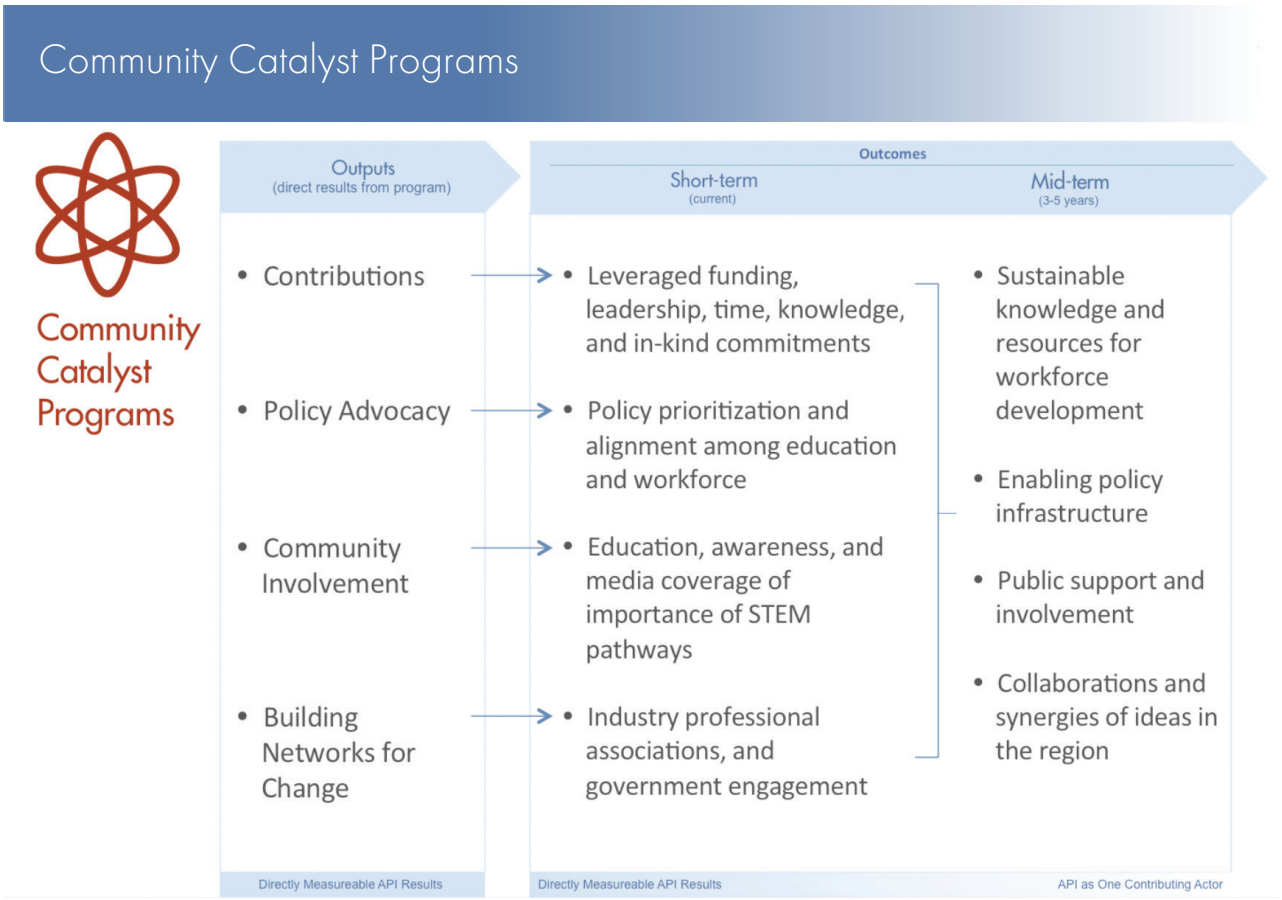
In the next section ,we discuss the contributions, policy advocacy, community involvement, and networks of API leadership in relation to K–12 STEM education. In sum, the API was engaged in regional, state, and national STEM education initiatives and policy discussions. API STEM programs collaborated with one another, and the number of local partnerships and partnerships across state lines have increased. At the same time, development of a well-defined policy agenda, coordination of API funding and activities, and interconnecting program and initiatives across state boundaries within the API region could be useful next steps.

While Additional Funding and In-Kind Contributions Were Leveraged from Others, Funding Could Be More Coordinated

By the end of 2017, Chevron had spent $14.7 million of its $20 million commitment to the API for both K–12 STEM and workforce-development programs; Benedum Foundation had contributed $4.9 million; and the Grable Foundation had committed $2.3 million. API leadership had also engaged a total of $11.9 million (including Benedum and Grable) in collaborative funding from other funders (see Figure 8); this amount does not include

FIGURE 7

API Community Catalyst Logic Model



Box 4
Theories of Action for the Community Catalyst Logic Model

Contributions. If regional stakeholders contribute funding, knowledge, leadership, time, and in-kind commitments (e.g., on-the-job training, equipment), then STEM education and workforce-development programs will be locally sustainable.

Policy advocacy. If regional stakeholders prioritize policies to align approaches to education with the needs of the workforce, then there will be an enabling policy ecosystem.

Community involvement. If there is education, awareness, and media coverage of the importance of STEM education and career pathways, then there will be public support and involvement.

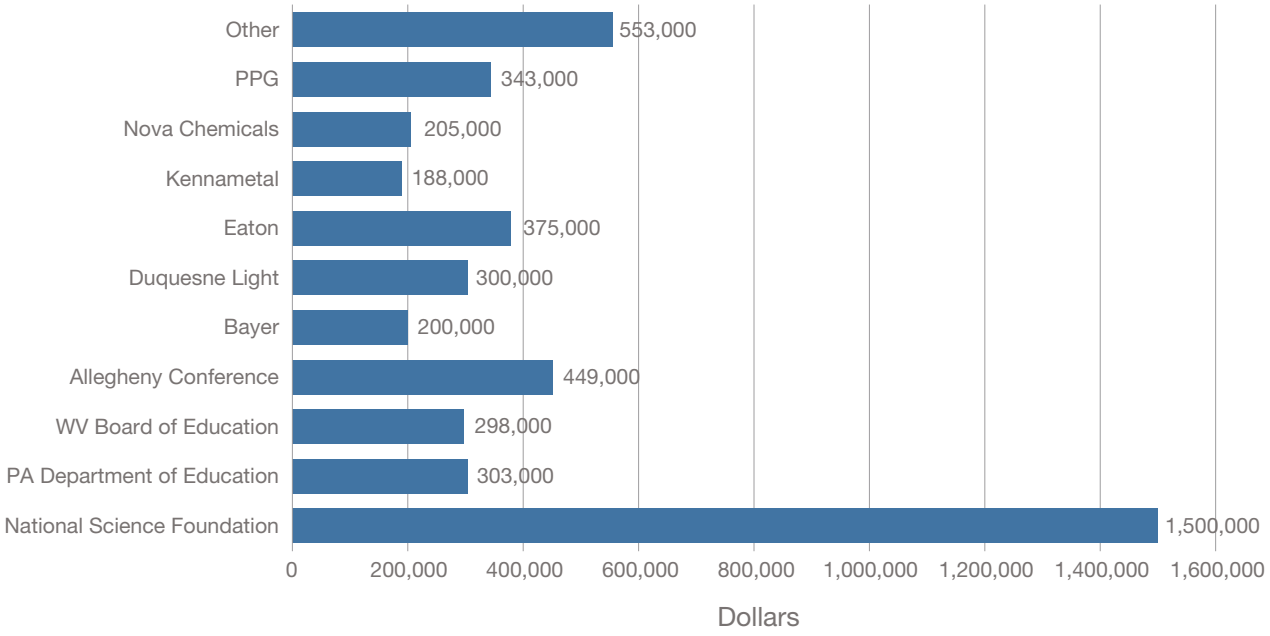
Building networks for change. If industry, professional associations, and government (federal, state, and local) are actively engaged, then there will be new ideas, policy, collaborations, and synergies in the region that support STEM education and career pathways.

matching funding that each of the programs had also collected for its other initiatives.

Figures 9 and 10 and Box 5 show the variety of external for-profit, nonprofit, and government partners that provided funding and in-kind support to K–12 STEM education programs. In particular, Education Alliance and IU1 had multiple additional funders, both showing increases from

FIGURE 8

Other Funding to API K–12 STEM and Workforce-Development Programs, 2017



SOURCE: Interviews with API leaders, July 2018.

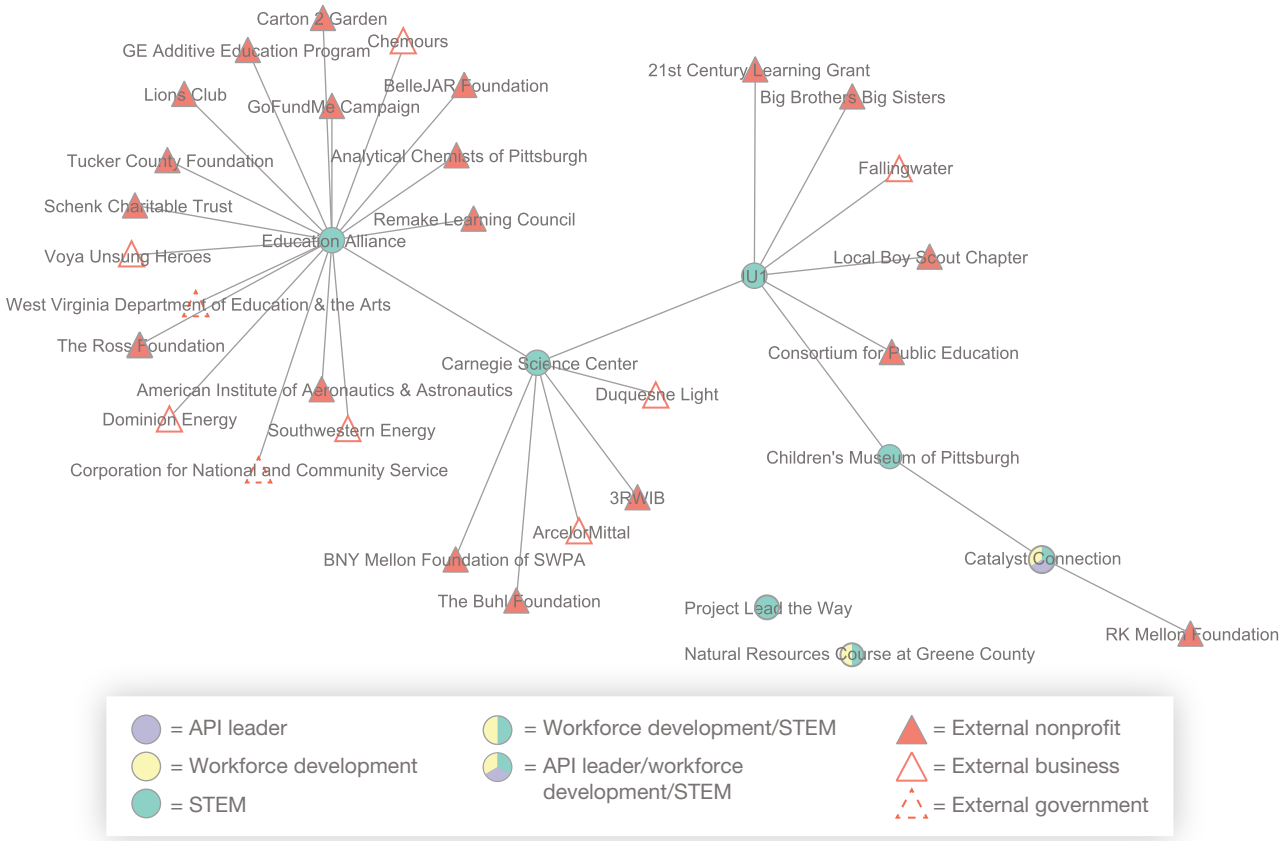
Box 5
Interpreting the Network Diagrams

Programs in the network diagrams (Figures 9–12) are coded according to their association with the API. All circles refer to API programs: Purple circles denote API leadership, yellow circles denote API workforce-development programs, green circles denote API STEM programs, and multiple-colored circles denote API programs that have multiple functions within the initiative (e.g., in Figures 10–11, the circle for the Natural Resources Course in Green County is green and yellow to show that it is both an API K–12 STEM program and an API workforce-development program). The triangles refer to external programs; in Figure 10, the shaded orange triangles denote external nonprofits, clear triangles denote external businesses, and clear-dotted triangles denote external government organizations. Figure 12 labels the external programs according to their state location to show partnership distribution across the tristate area: Ohio institutions are labeled by shaded blue triangles, West Virginia institutions are labeled by clear triangles, and Pennsylvania institutions are labeled by clear-dotted triangles.

The placement of the different organizations within a diagram is determined by the nature of their partnerships with other programs. Programs with a greater number of API partnerships are more likely to be present at the center of all connections (e.g., Catalyst Connection in Figure 10). Programs with only one connection to an API program will be present in the periphery of the diagrams (e.g., most of the external organizations in Figures 9 and 10). API programs with no connection to other API programs will seem to have a separate diagram (e.g., Natural Resources Course at Greene County in Figure 10). The length of the connection lines between programs do not hold any substantive meaning—they are simply the byproduct of the placement of programs within the diagram.

FIGURE 9

Funding Contributions to API K–12 STEM Programs



SOURCE: Interviews with grantee administrators, July 2018.

last year. Catalyst Connection had a large network of in-kind contributors, and Natural Resources, IU1 and Education Alliance also had multiple in-kind contributions. Some examples of program activities supported by external partnerships included U.S. Department of Labor funding for PLTW to develop a nationwide apprenticeship program for high schools; a partnership among IU1, Fallingwater, 21st century After School Program, and English-as-a-second-language summer camps to enhance IU1's Fab Lab curriculum and make their Fab Lab accessible to more students; and Americorps Vista providing Education Alliance's STEM Network schools with additional staffing to implement STEM curricula.

Although the STEM programs have extensive external partnerships, notably, each program has a distinct set of funders and in-kind contributors. There are few funders or contributors that give to multiple API programs, resulting in disconnected funding and in-kind networks. There are fewer external partners funding multiple API programs this year than there were last year. This suggests an opportunity for API leaders and programs to coordinate to seek funding together.

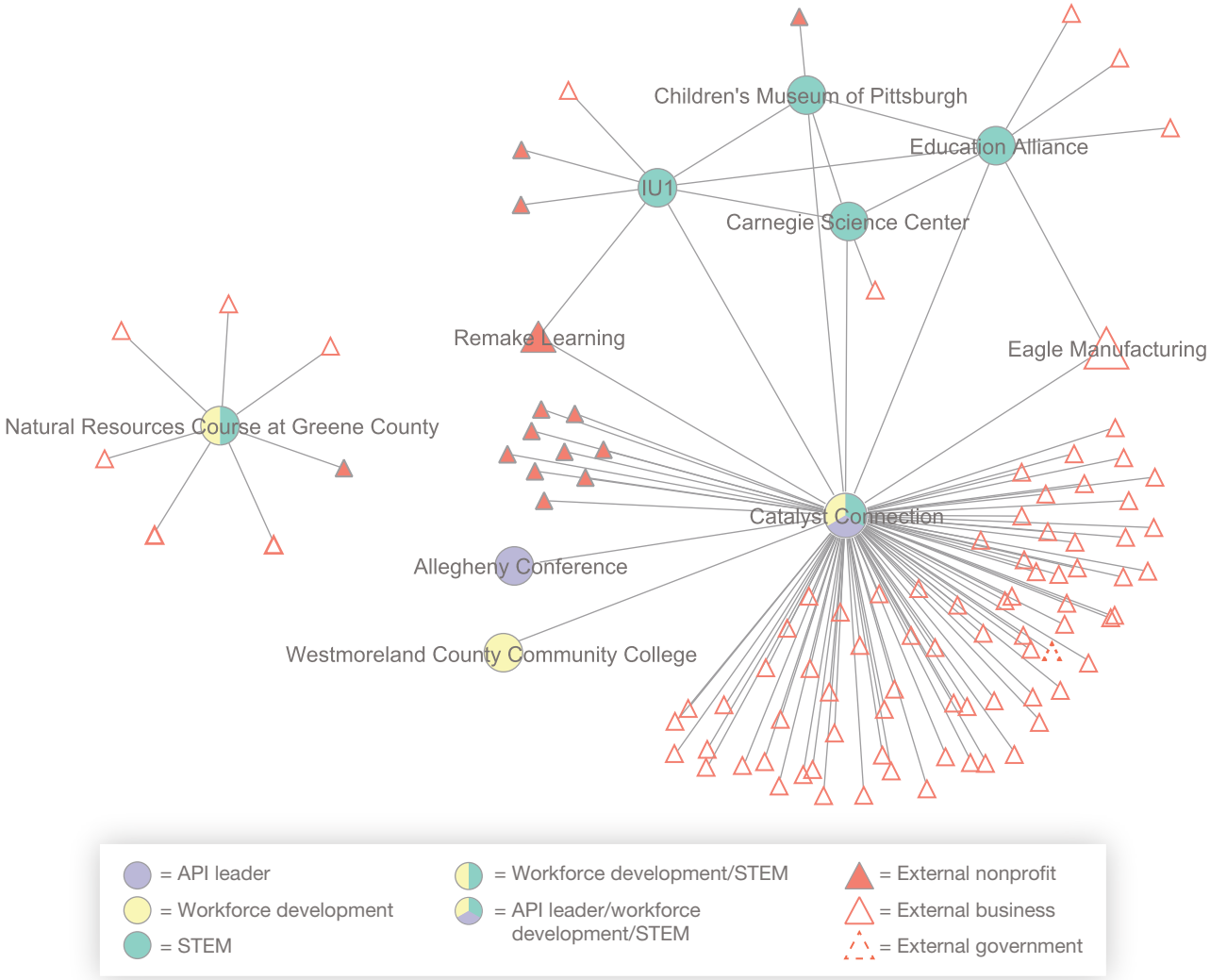
API Leaders and Partners Engaged Individually with Policymakers: A Common Set of Policy Priorities Could Be a Next Step

API programs and leaders actively engaged in state and national policy discussions, although they operated individually without a coordinated API policy agenda related to STEM education.

There were a variety of state and local policy activities. Chevron met with local and state officials in Pennsylvania to build awareness around API efforts and to reduce barriers to implementing STEM education initiatives. The Allegheny Conference and Grable began collaboration with business and

FIGURE 10

In-Kind Contributions to API K–12 STEM Programs



SOURCE: Interviews with grantee administrators, July 2018.

institution leaders in the greater Pittsburgh region to develop input for a policy agenda. The Grable held regular meetings with the Pennsylvania Department of Education; Chevron, IU1, and Grable were part of the Pennsylvania STEM Coalition, which focuses on STEM education policies in Pennsylvania. Similarly, the Education Alliance is a part of the West Virginia STEM Council and worked with the West Virginia State Department of Education to extend lessons learned from the STEM Network schools.

API programs and leaders participated in national discussions. Catalyst Connection presented on the advanced manufacturing industry's skills demands at the House of Representatives Manufacturing Caucus. IU1 participated in congressional Maker Faire discussions, which were coordinated by Chevron. Grable spoke at U.S. Department of Education events at the White House. The Allegheny Conference provided inputs during the reauthorization of the Carl D. Perkins Career and Technical Education Act of 2006, now known as the Strengthening Career and Technical Education for the 21st Century Act, into law.

At the same time, in interviews, a number of API leaders discussed the need for more-defined policy priorities, a clearer agenda, and roles for the

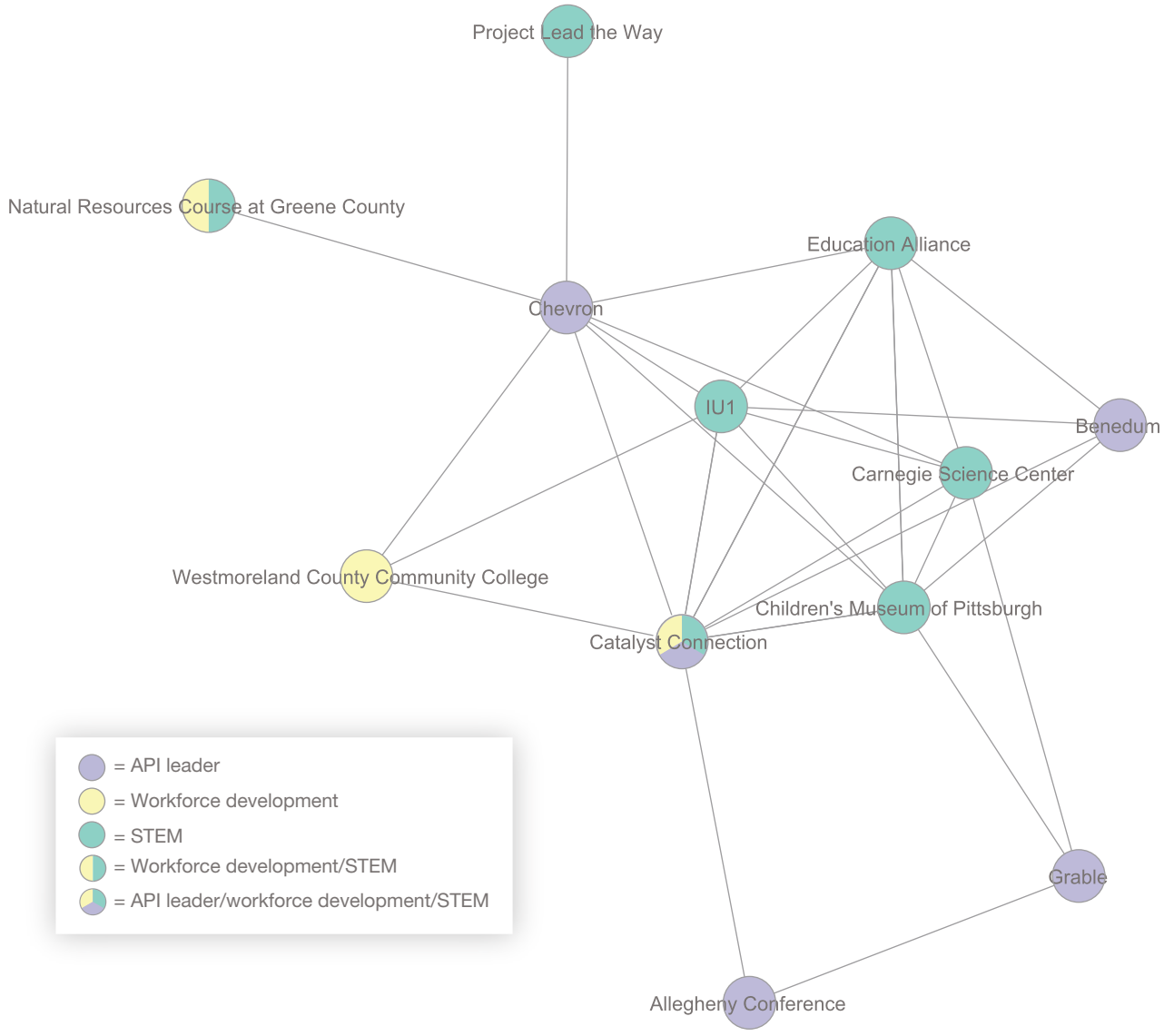
initiative. Some observed how most of the funding activities were conducted separately, making it difficult to assess the extent to which the API was achieving its goals. Several potential policy priorities described by API leaders included improving awareness and perceptions of STEM careers (both middle and high skilled), guidance counselor and teacher awareness of STEM career paths, and access to job and internship opportunities. However, to date, there is no systematic way for program grantees or API leaders to gauge or track awareness of program participants or the broader stakeholder community through surveys or polls.

API STEM Programs Collaborated with One Another and Other Local Programs

Programs collaborated with one another (see Figure 11) and with other initiatives that were not part of the API. For example, the Education Alliance STEM Network schools used the CSC STEM Excellence Pathway to guide STEM curriculum development. Several STEM Network schools also implemented

FIGURE 11

Collaborations Among API K–12 STEM Education Programs



SOURCE: Interviews with grantee administrators, July 2018.

the PLTW curriculum or contracted with IU1 for professional development resources. However, much like the findings from Gonzalez, Culbertson, and Nanda (2017a), API STEM education partnerships with API workforce-development programs were limited. As shown in Figure 11, Westmoreland County Community College was the only API workforce-development partnership that paired with API K–12 STEM programs; it partnered with IU1 and Catalyst Connection. As examples of collaboration with other partners, IU1 and Education Alliance provided advising for other local schools that were introducing Fab Labs or new STEM curricula, respectively. The West Virginia Department of Education adopted the model of Education Alliance's STEM Network schools when rolling out new STEM curricula elsewhere, and Marshall University in West Virginia also funded schools to replicate the STEM Network. API leaders were also involved in common community efforts. The Allegheny Conference, Benedum, Chevron, and Grable were all part of the Remake Learning Council, which oversees the Pittsburgh region's Remake Learning Network of organizations that strive to bring innovative learning to the area; IU1, Catalyst Connection, and Education Alliance were part of the Remake Learning Network as well.

API STEM Programs and Leadership Conducted Some Activities Across State Borders

A founding assumption of the API was that the 27-county greater Pittsburgh Appalachia region could be treated as a single labor shed, with implications that cross-state collaboration within that labor shed could enhance K–12 STEM education and workforce-development efforts. Some API programs and API leadership are connected with external partners across the tristate area, although these cross-state collaborations were limited. This indicates that most collaboration remains within a single state. There are numerous examples of the cross-state collaboration: IU1 provided digital fabrication consulting to local school districts in southwest Pennsylvania and expanded its consulting to West Virginia schools. Education Alliance arranged a site visit in Ohio STEM schools for its STEM Network schools to exchange views on good practice. Catalyst Connection expanded program activities to West Virginia through collaborations with workforce investment boards, other school districts, the radio station WQED, and its student manufacturing video contest. The Allegheny Conference, Benedum, and Chevron continued engagement with the Tri-State Shale Coalition, aiming to redesign postsecondary training for advanced manufacturing and promote careers in advanced manufacturing to middle and high school students in Ohio, Pennsylvania, and West Virginia. Chevron and Benedum also funded school-based aquaponic installations across the three states. Nationally, IU1 and Chevron participated in the U.S. Science and Engineering Festival in Washington, D.C., and discussed "making" in educational settings.

API Remained Engaged with Colleges, with Shifts in Emphasis

Connections between colleges (four-year, two-year, and career technical centers) and API programs are displayed in Figure 12. The numbers of connections grew since the previous interim assessment (Gonzalez, Culbertson, and Nanda, 2017a). API leadership described an increase in emphasis in collaboration with local community colleges, including work with the Community College of Allegheny County and the Beaver Community College for the Tri-State Shale Coalition. In previous years (2014 through 2016), the University of Pittsburgh and Carnegie Mellon University were major hubs of collaboration with API programs; in 2017, collaboration shifted instead to emphasize more-local universities and community colleges.

Much like the in-kind and funding networks, the STEM programs shared few college partners, with separate and distinct networks of university collaboration. The college networks were also largely separated by state lines. There were two major clusters of college collaboration: (1) a Pennsylvania cluster centered around IU1 and Catalyst Connection and (2) a West Virginia and Ohio cluster centered around Education Alliance and PLTW. As the API aims to build a tristate regional labor shed, API leaders

FIGURE 12

Collaborations Between API K–12 STEM Education Programs and Postsecondary Education Institutions

SOURCE: Interviews with grantee administrators, July 2018

* Greene County Career and Technical Center is not a college, but it provides adult education vocational programming.

might consider encouraging more shared college partnerships with programs that cross state lines.

Looking Ahead

As we reflect on the first three years (October 2014 through December 2017) of API funding to K–12 STEM education programs, there are a number of ways in which the API can bolster its efforts. In this section, we provide some recommendations organized by the research questions we addressed in this report.

Strategic Alignment

- Continue to make efforts to connect grantees' visions and goals with the strategic vision of the API. One way to do this would be to regularly convene grantees to confer with API

leaders as well as among themselves to deepen planning and visioning.
- Gauge participants' perceptions and awareness of STEM careers and API programs. This could occur by surveying teachers, students, and other program participants so that API leaders could track the progress of its programs in meeting their goals (with respect to changing awareness).
- Undertake an exercise to map pathways between K–12 education and middle-skill jobs. Career pathways are models that show which skills, degrees, and certifications can lead to specific STEM-related careers and middle-skilled jobs. These could be useful to support awareness and understanding among youth, parents, high school guidance counselors, and human resource professionals.

Beneficiaries

- Consider expanding programs into API counties in Ohio. Although API grantees have reached low-income students, girls, and students in rural communities, API leaders might consider expanding the geographic scope of programming so that more K–12 students in Ohio are reached by API programs.

Implementation and Sustainability

- Continue efforts to promote innovative K–12 STEM instructional practices, with professional development aligned with the API vision and logic model.
- Continue to seek diverse and coordinated funding streams to promote financial sustainability of programs.

Community Catalyst

- Develop the API's role in catalyzing the regional community in a common strategy, as the API could benefit from a more coordinated strategy for its initiatives. This could involve a set of workshops related to updating API approaches and strengthening community and interaction among programs.
- Coordinate funding opportunities among API leaders and the wider donor community. This could entail regional funder meetings to develop common priorities and funding approaches.
- Build more extensive tristate partnerships and initiatives, building on foundations already in place through the API and other initiatives. There are a large number of partnerships still within state lines, and the majority of the activity is within the southwestern Pennsylvania/Pittsburgh region, with less activity in the Ohio portion of the API footprint.
- Measure the impact of these efforts on student achievement in STEM and entrance into STEM college and career pathways as time passes, in addition to studying process measures of the first few years of the API. Potential measures to consider include high school graduation, college attendance, and/or job attainment and performance.

Notes

[1] Gonzalez et al. (2016) and Gonzalez, Culbertson, and Nanda (2017a, 2017b) found that jobs in STEM-related industries and fields have been increasing across the 27 counties in the API region, those in other industries and fields have been decreasing. The supply of high school and college degree recipients in STEM fields may not be able to keep pace with that demand.

[2] Gonzalez et al. (2015, 2016, 2017, 2019); Gonzalez, Culbertson, and Nanda (2017); and Bozick et al. (2017) found that, in interviews and surveys employers in Pennsylvania, Ohio, and West Virginia, people reported difficulty in filling STEM jobs and attracting talent, especially in for middle-skilled jobs that require STEM skills.

[3] See Gonzalez et al. (2016, 2017) for more information about the shrinking working-age population in the 27 API counties: Most counties in the API region experienced a decrease in the working-age population. Furthermore, Gonzalez et al. (2016, 2017) and Gonzalez, Culbertson, and Nanda (2017a) note that given the impending retirements of large cohorts of older workers, if the demand for middle-skilled workers remains the same as it was at the time of this study (in 2018), the growing need for a STEM-skilled workforce is likely to intensify. The aging workforce could more deeply affect workforce needs in the energy sector; nearly 25 percent of workers employed in extraction and production occupations are over age 55 and nearing retirement (Porter, Gee, and Pope, 2015).

[4] Regarding veterans, see Martorell et al. (2014). Regarding rural residents, see Pollard and Jacobson (2015), Center for Regional Economic Competitiveness and West Virginia University (2015), and Klesta (2009).

[5] U.S. Energy Information Administration, 2016.

[6] U.S. Energy Information Administration, 2017b.

[7] U.S. Energy Information Administration, 2017a.

[8] U.S. Energy Information Administration, 2016.

[9] U.S. Energy Information Administration, 2017b; U.S. Energy Information Administration, 2018b.

[10] U.S. Energy Information Administration, 2018a.

[11] U.S. Energy Information Administration, 2017a.

[12] U.S. Energy Information Administration, 2016.

[13] U.S. Energy Information Administration, 2018d.

[14] U.S. Energy Information Administration, 2017a.

[15] U.S. Energy Information Administration, 2018d.

[16] See "Appalachia Partnership Initiative," undated, for an interactive tool of the API region and grantees' data. The tool highlights the geographic reach of API programs and allows users to drill down and see specific information about each funded program.

[17] For more information about how these questions were developed, see Appendix B in Culbertson, Gonzalez, and Nanda, 2017.

[18] More information about data sources can be found in Appendix B of Culbertson, Gonzalez, and Nanda (2017).

[19] The quantitative indicators were developed in July 2015 in deliberation with API leaders; each indicator linked directly to a component of the strategic logic model. At this point, program administrators were able to report on the direct services provided by their programs and the number of participants ("outputs" in the strategic logic model). A sample data collection template is available in Appendix H in Culbertson, Gonzalez, and Nanda, 2017.

[20] A copy of the interview questionnaire is available in Appendix G in Culbertson, Gonzalez, and Nanda (2017).

[21] See "Appalachia Partnership Initiative" (undated) for interactive maps with specific information about the API and the programs it is investing in. For more information about the methodology employed, see Appendix B in Culbertson, Gonzalez, and Nanda (2017).

[22] For more information about how the strategic logic model and study questions were developed, see Appendix B in Culbertson, Gonzalez, and Nanda (2017).

[23] Workforce-development programs and their logic model will be discussed in a forthcoming report.

[24] See Gonzalez, Culbertson, and Nanda (2017a), for a list of all programs funded by the API.

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About This Report

This report is the second interim assessment of the Appalachia Partnership Initiative's (API's) progress toward meeting its goals and vision. The first report, *The Appalachia Partnership Initiative's Investments in Education, Workforce Development, and the Community: Analysis of the First Stage, 2014–2016*, is available at www.rand.org/pubs/research_reports/RR2017.html. The technical appendix for the first report, which documents the study's methodology and data and expands on the findings summarized in the first report, is available at www.rand.org/pubs/research_reports/RR2017z1.html.

This report should be of interest to leaders in regional education, business, and the community concerned with science, technology, engineering, and mathematics (STEM) education and the career readiness of workers in the energy and advanced manufacturing sectors and policy analysts interested in how network analyses can help advance regional innovation.

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RAND Education and Labor conducts research on early childhood through postsecondary education programs, workforce development, and programs and policies affecting workers, entrepreneurship, and financial literacy and decisionmaking. RAND Social and Economic Well-Being seeks to actively improve the health and social and economic well-being of populations and communities throughout the world. More information about RAND can be found at www.rand.org.

The Appalachia Partnership Initiative

Chevron North America Exploration and Production (CNAEP) Appalachian Mountain Business Unit's Social Investment Team was established to meet several goals in the Pennsylvania, West Virginia, and Ohio region. Goals include strengthening STEM education in middle and high schools and improving pathways for high school graduates and adult learners to careers in the oil and gas industries and in advanced manufacturing. As part of these efforts, in 2014, Chevron's Social Investment Team launched the API, a partnership of businesses, nonprofit organizations, and education institutions in the region. As of August 2018, API leaders consisted of representatives from Chevron, the Claude Worthington Benedum Foundation, the Grable Foundation, the Allegheny Conference for Community Development, and Catalyst Connections.

The RAND Corporation has served continuously as the independent research and analysis lead for the API. RAND is undertaking annual assessments from 2016 through 2020 to track the progress that API-sponsored programs are making in supporting the API's goals over time.

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