Center for Research
in SEAD Education

Inventory of Statewide STEM Education Networks: Final Report

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Introduction and Overview

Multi-sector partnerships to promote engagement in science, technology, engineering, and mathematics (STEM) have been in operation across our nation for over 30 years. These STEM "networks" have been made possible through dynamic collaborations across P-16, the private sector, community-based organizations, and STEM-based institutions such as museums, science centers, and professional organizations. In addition to providing high-quality STEM experiences for all young people, these partnerships have become a key strategy to address workforce development in the STEM areas, hence attracting more support from business and industry.

Early configurations of statewide initiatives were conceptualized as networks (e.g., the North Carolina Science, Mathematics, and Technology Education Center, the Ohio STEM Learning Network), often with a central office and satellite hubs. More recent partnerships have been developed using the notion of an "ecosystem" to emphasize the systemic, shared, and dynamic nature of the enterprise. STEM ecosystems, such as those funded through groups like the STEM Funders Network, support the creation and initial operation of communities of practice that "nurture and scale effective science, technology, engineering, and math (STEM) learning opportunities for all young people" (http://stemecosystems.org/about/). Traphagen and Traill (2014) reported their analysis of 15 leading STEM learning ecosystems to articulate the attributes and strategies that have created successful, sustainable partnerships. The National Academies of Science, Engineering, and Medicine published their analyses of promising practices for developing STEM workforce development ecosystems (2016). More recently, Vance, Nilsen, Garza, Keicher, & Handy (2016), Weld (2017), and Zinth and Goetz (2016) offer guidelines for the development of networks or ecosystems based on successful practices. Clearly, these formalized partnerships have provided the architecture and motivation to advance STEM literacy, skill building, and, workforce development, and will continue to STEM opportunities for the forseeable future.

Project Context and Background

Emphasis on high quality STEM education has been at the forefront of our workforce development and national security imperatives since the era of Sputnik. In the past 30 years, multi-sector partnership development has been a key mechanism to create STEM programming aligned with the needs of business and industry to ensure thriving economies and communities. Since the inception of the White House Office of Science and Technology Policy in 1976 and the President's Council of Advisors on Science and Technology in 2001, the federal government has identified multi-sector partnerships key to economic development and national security. The National Academy of Sciences', National Academy of Engineering's, and Institute of Medicine's 2007 report, *Rising Above the Gathering Storm* underscored this need. Most recently, the Committee on STEM Education of the National Science and Technology Council underscored the development of STEM ecosystems to advance STEM learning communities to "focus on the long-term, shared, sustainable, and flexible STEM missions that bridge, integrate, and

strengthen the learning opportunities offered by organizations across sectors compared with isolated, independent entities (Committee on STEM Education, 2018, p. 10).

The vision that "all Americans will have lifelong access to high-quality STEM education and the United States will be the global leader in STEM literacy, innovation, and employment" (Committee on STEM Education, p. v), represents the foundational reason why this research was launched almost three years ago. Beginning with roundtable discussions at the 2014 conference for the Network of STEM Education Centers (NSEC), university faculty from across the nation shared the status of the STEM networks operating in their home states. While many states had established statewide and regional entities and were in the midst of updating, revising, and, in some cases, reviving enterprises given changes in economic, personnel, and missions, some states were just exploring the potential and possibilities for their own networks.

After two years of conversations at annual NSEC conferences, as well as the expressed interests of leaders from a number of statewide STEM networks to understand the status of these enterprises across the nation, this inventory was launched with the intent to catalog the statewide networks and their specific features to serve as a resource. The original purpose of this study was to create an inventory of STEM networks at the *statewide* level. However, during the course of the data collection, it was clear that STEM networks organized at different geographic levels were impacting each other, and often referenced as partners across the networks. So, in order to create the first attempt at a comprehensive inventory of the partnerships, listings of networks at the international, national, statewide, regional, and metropolitan levels were developed. Our hope is that this inventory will serve as a basic resource for P-12 schools, higher education, business and industries, community and government agencies, professional organizations, museums, science centers, and citizens at large to advance collaboration, engagement, stakeholder support, and further understanding of best practices to sustain these partnerships.

Methodology

Our first step was to define a "STEM network" operationally. Based on the literature and recommendations from the project's advisory board and consultant, we concluded that our definition of a STEM network needed to be inclusive in order to cast a broad net that could then be narrowed as data were compiled and cleaned. As such, for the purposes of this study, a STEM network is:

"A formal cross-sector partnership designed to advance access to and engagement with high quality science, technology, engineering, and mathematics learning experiences for all:

- Other subject areas (e.g., art, agricultural, health, etc.) may also be a part of the mission.
- Shared goals and respect for each stakeholder's role and needs are central to the collaboration."

Using a mixed-methods, phased, "snowball" approach (Creswell & Clark, 2011), the overall data collection process was:

1. Identify networks found readily on the internet using keywords such as STEM networks, STEM centers, STEM partnerships, and STEM ecosystems. This initial scan would yield the major networks and relevant information publicly available for any stakeholder to find and make connections. In terms of the investigation, this information provided the basic knowledge of the networks available in each state and a listing of possible directors to interview for more in-depth study.

2. Using a survey approach, identify networks that STEM education professionals know about that promote education, engagement, and partnerships. The organizations that were surveyed included the International Technology Education and Engineering Association (ITEEA), the National Alliance for Broader Impacts (NABI), the Network of STEM Education Centers (NSEC), and the American Society of Engineering Educators (ASEE) – Pre-college Division.

3. Contact STEM leaders at the state and national level who would recommend STEM network directors for in-depth interviews on their networks' operations, successes, and challenges that might not appear on the websites.

Undergraduate and graduate students from STEM-related majors assisted in the data collection process as a research experience. Additionally, as information was being collected, we were able to host a seminar for the students to reflect on the magnitude of the STEM network enterprise and possible ways that these networks may impact their future careers.

The project's timeline and data collection procedures were:

Phase I: Fall 2016-Spring 2017

- Partnered with undergraduate researchers for initial data collection
- Conducted internet searches; development of the spreadsheet using available information
- Identified STEM network leaders for phone interviews
- Developed survey and IRB permission; email distribution of surveys secured[1]

Phase II: Spring-Summer 2017

- Partnered with undergraduate and graduate researchers
- Finalized surveys and phone interview protocols
- Conducted phone interviews (n=12) and survey of ITEEA membership (n=7)
- Presented at the Conference on Higher Education Pedagogy (CHEP) and NABI Conference

[1] All surveys were distributed by the hosting professional organization.

Phase III: Summer-Fall 2017

- Gathered feedback from Advisory Board regarding preliminary findings
- Presented at the NSEC Conference
- Conducted surveys of the NABI (N=39) and NSEC (n=51) memberships (completed)
- Aggregated and cleaned available survey data
- Collected data from Jan Morrison/TIES re: statewide networks and the STEM Ecosystem project; also reviewed aggregated data with Morrison for corroboration
- Conducted STEM network director interviews
- Conducted a survey of ASEE/Pre-College Special Interest Group

Phase IV: Fall 2017-Fall 2018

- Continued to collect and verify data in database
- Completed final data cleaning and aggregation
- Reviewed the current literature on STEM networks
- Completed the final report

On-Going: Winter 2018/2019-

- Developing an interactive website with maps that display the locations of the networks, network names, directors, and contact information; opportunity to edit the database as well as add new networks to the directory.[2]
- Continued research/analysis of network missions, organizational structures, fiscal plans, etc.

The specific information extracted from the internet/website searches, when available, was:

- Type of network (e.g., regional, statewide, formal/informal education, etc.)
- Location
- Affiliation with national or international networks
- Leadership
- Contact information
- Mission and goals
- Funding sources

The website searches yielded a wide range of network profiles, coverage areas/regions, and partners. In order to collect more detailed information network operations, the leadership of 8 networks, was interviewed by telephone. In addition to gathering data on the elements outlined above, questions were asked about the following:

- Staffing
- Governance and Infrastructure
- Communications

[2] This work is ongoing with public availability in 2019.

- Activities and events
- Evaluation results; evidence of broader impacts
- Successes and challenges

Interviews were conducted with eight directors whose networks represented contrasting cases in terms of network longevity, size, and scope. Seven of the interviewees were directors of a statewide STEM network or hub. One interviewee served as the director of an international network. A brief description of each network, identified with numbers to protect confidentiality, is as follows:

- Network 1: Funded by NSF, just starting out as a state-wide entity to focus on providing opportunities for underserved P-12 students. Partners included a university and state agency.
- Network 2: A statewide 501c3 that has strong partnerships with the state education agency, universities, and corporations. This network was scaling up to operate on the national level.
- Network 3: A regional university-affiliated center funded by the university that was tasked to increase services and influence across the state.
- Network 4: A statewide network with hubs all across the state. In operation for two decades, was approaching a challenging future with a greatly reduced budget.
- Network 5: Started as a STEMx statewide network, had great support from a university president who facilitated corporate funding to launch the effort. Leadership changed, and now operating within the resources of a university budget.
- Network 6: Another 501c3 operating on a statewide level. Large staff, all full time. Relies on university support from across the state.
- Network 7: An international grant-funded network operating in six regions around the world. Focused on a particular discipline, this network orchestrates implementation of curriculum, activities, and evaluation from all partners. on grants and corporate funding.
- Network 8: A 10-year old regional hub in a statewide network that is primarily grant-funded, but also affiliated with the university in that region. Services focus on P-12/community activities.

Decisions about data included for analysis were based on advisory board recommendations, expected areas of interest by those using this resource, and the resources supported by this project. Given that the emphasis was to identify multi-sector partnerships, centers or organizations that provided STEM learning services to their own constituents (i.e., employees, students, faculty, etc.) were excluded. For example, university teaching centers that provided professional development for the faculty in order to improve the teaching of STEM content to the university students were not included. Networks that provided learning opportunities outside their business, university, or school, and whose intention to improve overall STEM literacy, skills, career pathways, etc. were included. Of course, given that much of the data was extracted from websites, many networks may have been missed or not showcased on the internet, or their mission statements/purposes were not clearly conveyed in their web content.

Results

Currently, STEM networks with widely varying partnership configurations appear to be operational in all states and four of the five territories (except American Samoa). Based on our current data, 302 STEM networks were identified through internet searches, surveys, and interviews. These data are based on four separate internet searches, surveys completed by four different professional organizations (n=97), and 8 interviews. While some networks stood alone, many are nested in larger coordinating bodies (i.e., central leadership, satellite hubs or regional networks with context-specific foci, national and international networks). And, not all networks at specific levels are have the same number of partners or sectors, resources, activities, etc. That said, given that most data emanated from internet searches, the reliability of the data is subject to the selected keywords, live links, and information available on any given website on any given day.

In terms of sheer numbers, the totals noted below represent the networks in operation at each level, with the recognition that some of the state networks are part of a larger international or national organization (e.g., STEMx), serving as state- or regional-level "hubs" of the parent national or state-level organization. The complete listing is available in Appendix A[3]. Also included in this inventory are the networks' directors or contact personnel, contact information, and missions. Appendix B provides a listing of the statewide STEM networks by state and notes which states have a formalized hub system. Using the main office locations for the STEM networks, preliminary static maps were developed to depict the distribution given our current data at each level. The maps are located in the appendices noted in the listing below.

As of August 2018, the numbers of networks identified at each level, with each level's operational definition, were:

- International: Organizations that provide services across the world but are based in the United States (e.g., the International Technology and Engineering Education Association-ITEEA) (n=8). See Appendix C for map of home offices for international networks.
- National: Organizations that provide services across states (e.g., STEMx) (n=46). See Appendix D for map of home offices for national networks that have branches in any number of states and territories.
- Statewide/Territory-wide: Organizations that provide services across an entire state (e.g., state departments of education, governors' advisory boards) (n=90). See Appendix E for map of home offices for statewide or territory-wide networks.
- Regional: Organizations that provide services within a particular region of a state that includes multiple counties and/or jurisdictions (e.g., SySTEMic Solution, Northern

[3] Please contact Susan G. Magliaro (sumags@vt.edu) for permission to access the inventory. An interactive website with the network inventory/directory and mappings of the networks by levels is forthcoming.

Virginia) (n=135). See Appendix F for mapping of home offices for networks serving specific regions.

- Metro: Organizations that provide services across a metropolitan area or city's boundaries (e.g., Newark STEAM Coalition, Newark, NJ) (n=23). See Appendix G for mapping of home offices for networks serving metropolitan communities.

Network leadership. Identification of network leadership and contact information were captured primarily available from the internet. Network leadership was available for the most part, along with contact information. However, many networks identified a contact person or just a contact form to be completed on the website. When based at a university, leadership is provided by a director, often a faculty member in the STEM disciplines. When based in a state department of education, leadership is provided by the department employee aligned with the focus of the network (i.e., academic/disciplinary v. career and technical education). When the network is a for-profit or not for-profit, the leader is often identified as a chief operating officer or executive director. In some cases, there were leadership teams where a small group seemed to share the work. In either of these cases, there is likely to be a board of directors, mostly composed of business leaders whose businesses sponsor network activities.

Mission statements. Mission statements also were collected from each network. If a mission statement was not available, vision statements, listings of goals, or purpose or focus statements were recorded. The range of length, number of concepts, etc. was quite variant. However, using a word cloud software package, the primary words that framed a network's mission were apparent. As might be expected, "STEM" was the primary word used across mission statement. Education, students, science, learning, and community were the next most frequently used words. Technology, engineering, and development ranked third. Further analysis of mission statements is in progress and will be available on the network directory/inventory website.

Staffing. A network's staff size, of course, depends on the funding in terms of budget size, source, and stability. While some networks had staff sizes of 15-30, the majority of networks were operating with less than five people, many of whom were part-time. Volunteers provided a great deal of personnel support, especially at specific events like science festivals, camps, etc. Some of the directors of networks were retired individuals, working part time or for free.

Governance/Infrastructure/Communications: Governance depends on the sponsorship of the network. For most 501c3's, an advisory board or board of directors was common to find during the online searches and in the interviews. Often these board members were from the vested corporations and agencies. Infrastructure was also dependent upon the network sponsorship, but also the budget and potential volunteer labor source. In addition to community volunteers, networks optimized the help of university students, retirees, and other community members. Communication is largely done via the internet, listservs, and newsletters. In terms evaluation plans or evidence of success, some organizations published their annual reports or brief information about numbers of network event participants.

However, this information was not frequently or easily found unless the network was very successful in terms of numbers and funding.

Activities and events: Most of the networks hosted a large annual event such as a summit, conference, festival, fair, or career exposition. When focused on children and youth, camps, afterschool programs, weekend programs, etc. were commonly offered opportunities. When older individuals were involved, career fairs with opportunities to meet with potential employers were offered. In addition to large events, many networks offered teacher professional development workshops, mentoring for teachers and students, school visits by local employers, etc.

Evaluation results/evidence of impact: Evidence of program evaluation activities, including reports, were found infrequently on websites. Most of the interviewees admitted weak evaluation plans and annual reports with general data. Robust evaluations, when available, were mostly from networks that had in-house evaluation personnel or who partnered with universities for voluntary/student service work.

Successes and challenges: Successes and challenges have primarily been ascertained from the interviews. Across the interviews, common issues that impact an organization's health and future are:

- Money: Funding related to availability of grants, support of state legislators, investment by business and industry, etc.; in most cases, the most stable networks had significant funding through corporate interests.
- Leadership: Leadership experience, turnover, changes in priorities, loss of advocates, etc. all seem to create challenges for directors. In fact, three of the seven directors interviewed for this study had left the director's role when study data was verified in August 2018.
- Staffing: The majority of networks operate with very limited staffing. Directors range from faculty who have the network as part of a workload. Retirees, students, parents, and other volunteers are essential for program delivery for many networks. Succession planning is rare. Again, these issues relate to the nature of the network and source of funding.
- Mission: Networks must be responsive and nimble to ensure that the mission and goals are meeting stakeholder needs, especially those of the funders. Four of the 7 statewide network directors interviewed for this study revealed they were in the midst of re-visioning or reorganization. The reasons for the changes varied from new leadership, to legislative priorities, or a reorganization at an upper level that now impacts the network's focus and operations.
- Network community: A few of the directors reported that a great challenge is keeping the network activities exciting and new in order to maintain interest and participation. Also, when the governance shifts to needing more community involvement, either due to budget or a shift in the network's governance framework, participants may step back leaving a gap in being able to offer high quality programming, communication, etc.

Summary and Next Steps

The STEM Networks Inventory project revealed that a great deal of effort and resources have been and continue to be invested in the advancement of high quality STEM-related experiences primarily for the P-12 sector. Moreover, the multi-sector commitment to increase these opportunities underscores the importance of the work. Given the fact that each internet scan yielded new networks, new incarnations of existing networks, new leadership, etc., it is clear that this is a dynamic enterprise. That said, four lessons were learned about statewide STEM networks, perhaps most directly from the directors themselves:

- Many of the networks operate from year-to-year on an uncertain budget. Even longstanding networks hit difficult periods when the future is unknown. Perhaps the most stable networks are those with either line-item budgets from legislators, or a group of committed corporations that have a vested interest in ensuring that children, youth, and adults have the literacy, and in most cases, knowledge and skills to meet workforce needs.

- As with most efforts, competent and committed leadership is essential. Leaders need to provide stability to the organization by remaining at the helm for a significant period of time or need to have a succession plan that ensures smooth transitions. During the two years of data collection for this project, identifying leadership for the networks was the greatest challenge.

- For the most part, networks run with minimal and, often, itinerant staffing. This, of course, depends on the budget, long-term investment, etc. However, for most of the networks, the predictable staffing included a director and staff/administrative support person. Volunteers were essential for the operation and continued success of the network.

- Network missions and activities must be responsive to the funding sources and availability, stakeholder needs, and the commitment by stakeholders to engage in network activities, responsibilities, etc.

In summary, networks, especially in their nascent years, are fragile enterprises. The long-standing networks tend to have had statewide governmental and corporate commitment, as well as financial support. Moreover, statewide STEM strategic plans play a critical role in providing the foundation and impetus for networks to thrive. Having a unified and consensus vision for the network, as well as clear communication channels, enables all partners to support each other, understand potential conflicts, and recruit new leadership to sustain the effort.

During the course of this project, we realized that our original goals were very ambitious, and that findings in this report and resultant inventory/directory serve as the

groundwork for continued research and development. Our first step is to open the inventory to the STEM community and create a website that includes:

- the inventory with a searchable database,
- a series of interactive maps that displays the locations of the home offices of the networks, and
- a mechanism for submitting edits to the current entries, as well as add new networks along with information about leadership, contact information, mission, etc.

Second, the information resulting from an initial analysis of the mission statements, organizational structures, network affiliation, funding models. Based on the interview data, all appear to be critical to the network's sustainability. Coupled with the number of changes we have had to make to the entries over the past two years, it is clear that these data are dynamic and are in need of constant scrutiny.

Third, the mapping of the networks also reveals interesting patterns of the locations of the networks. Specifically, this first mapping exercise revealed a number networks at work in some geographic areas, and few in others. Questions related to need, access, affordability, advocacy, etc. emerged. Further investigation of these observations will coincide with the website development.

Our final note is to welcome edits to our inventory/spreadsheet. Our plan is to update the inventory quarterly. Given the volatility of the data over the past 2 years, we are clearly aware that information changes rapidly. And, we also are appreciative of network personnel and partners' feedback and general information that helps us keep the extant database accurate. Please send all edits and suggestions to Susan Magliaro (sumags@vt.edu).

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APPENDIX A:

STEM Network Inventory Directory

https://drive.google.com/file/d/1rZzCxjgAprUFO7AmCq1JaHHMFabaT1uW/view?usp=sharing

APPENDIX B: Numbers of statewide STEM networks with related hub information

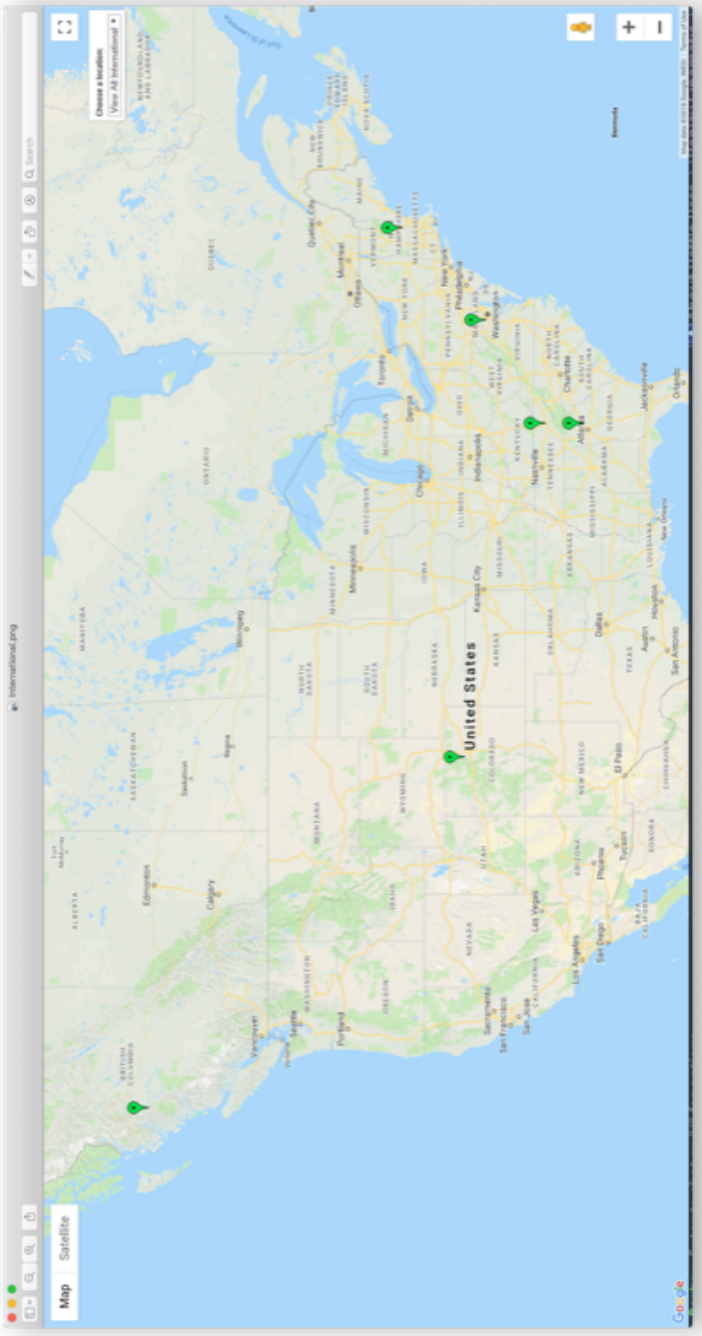
State	Statewide	Regional	Metro	Statewide Networks w/Hubs
Alabama	2			
Alaska	2			
Arizona	2	2	1	
Arkansas	4			
California	3	11	1	Ch1ldren Now: 9 hubs
Colorado	2	1		
Connecticut	1			
Delaware	1			
Florida	1	2	1	
Georgia	4	1		
Hawai'i	3	1		
Idaho	1			
Illinois	2	2	2	
Indiana	1	2		
Iowa	1	6		Iowa Governor's STEM Advisory Council: 6 hubs*
Kansas	1			
Kentucky	1	1		
Louisiana	1	1	2	
Maine	2	2		
Maryland			1	
Massachusetts	2	8	1	STEM Nexus: 8*
Michigan	2	2		
Minnesota	2			
Mississippi	1			
Missouri	2	1	1	
Montana	2			
Nebraska	4		1	
Nevada	1			
New Hampshire		1		
New Jersey	1	3	1	NJ Pathways: 4 hubs
New Mexico	3	1		
New York	1	11	4	Empire State Learning Network: 10*

North Carolina	4	3		
North Dakota	1	10		
Ohio	1	9	1	Ohio STEM Learning Network: 7*
Oklahoma	3	3		
Oregon	1	10	1	STEMOregon: 11
Pennsylvania	4	5	2	
Rhode Island	1			
South Carolina	1	5		S2TEM Centers SC: 5*
South Dakota	1			
Tennessee	1	7	1	Tennessee STEM Innovation Network: 7
Texas	4	9	1	Texas STEM Coalition: 6
Utah	1			
Vermont	1			
Virginia	3	3		
Washington	2	11		Washington STEM Network: 11
West Virginia	1			
Wisconsin		2		
Wyoming	1			
District of Columbia			1	
Territories				
American Samoa				
Guam	1			
Northern Marianas Island	1			
Puerto Rico	1			
Virgin Islands	1			
Totals	90	135	23	

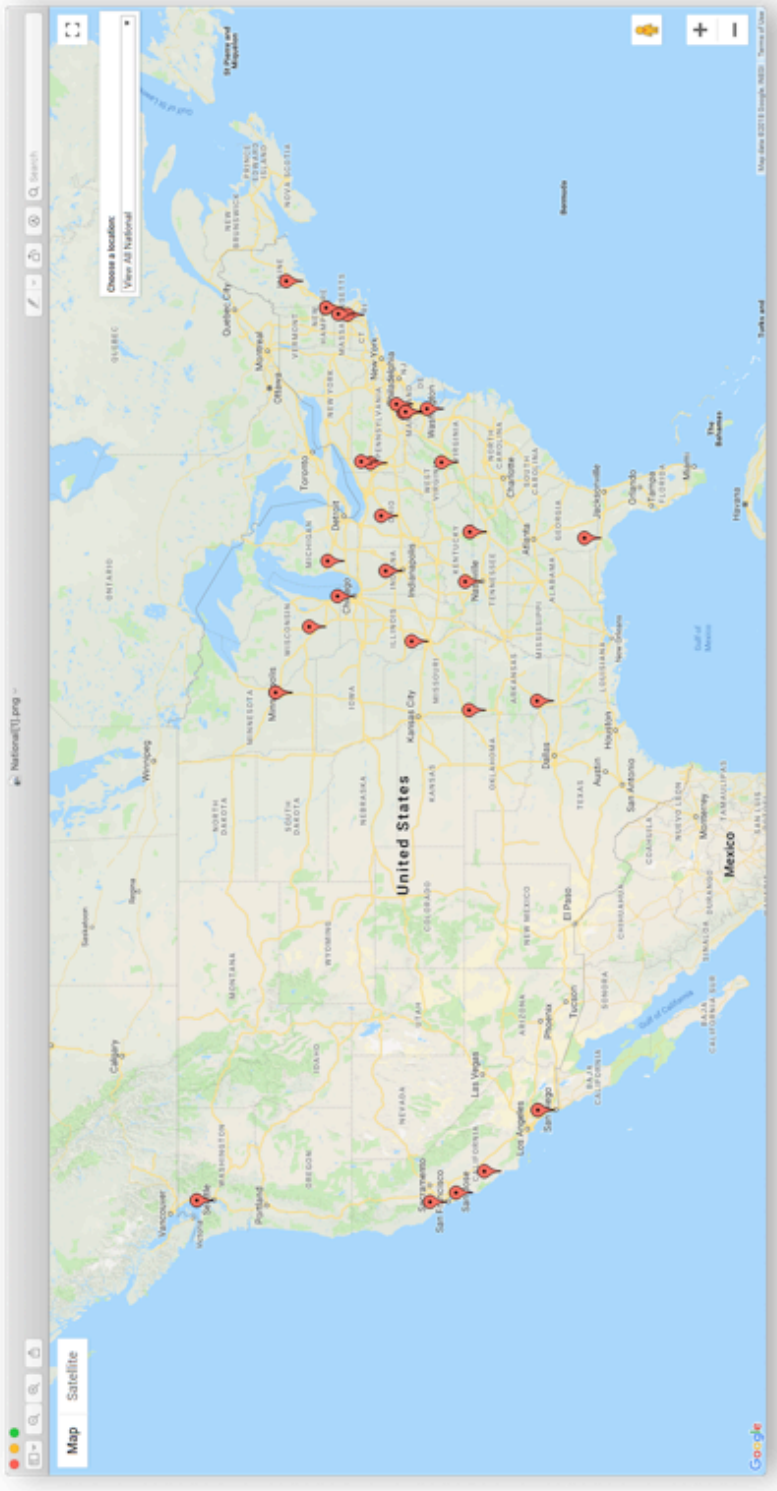
Table X. Numbers of STEM networks by state.

*STEM Network/Hubs cover the entire state to ensure all localities are connected to a hub and have access to services.

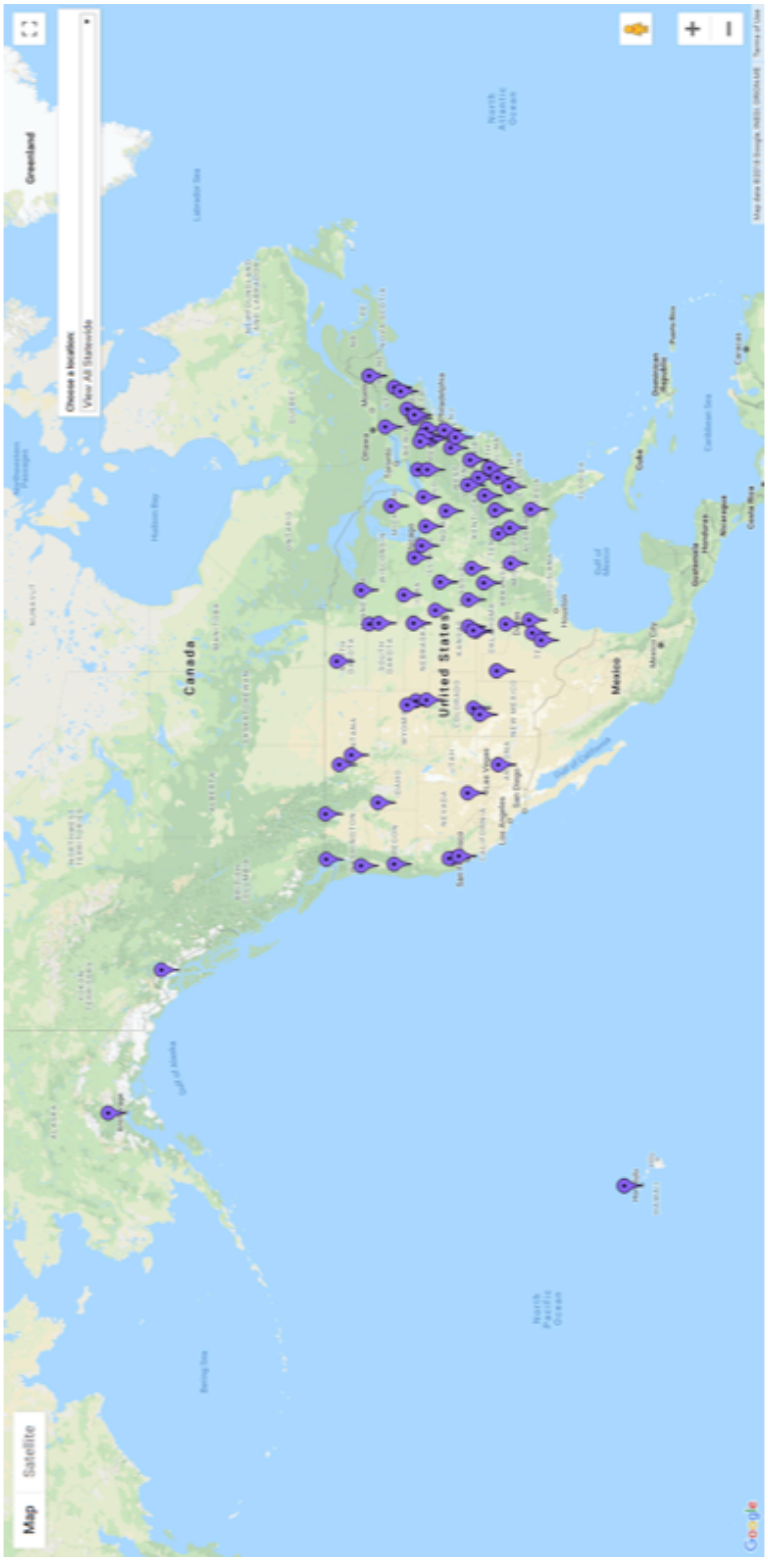
APPENDIX C: US-based International Networks



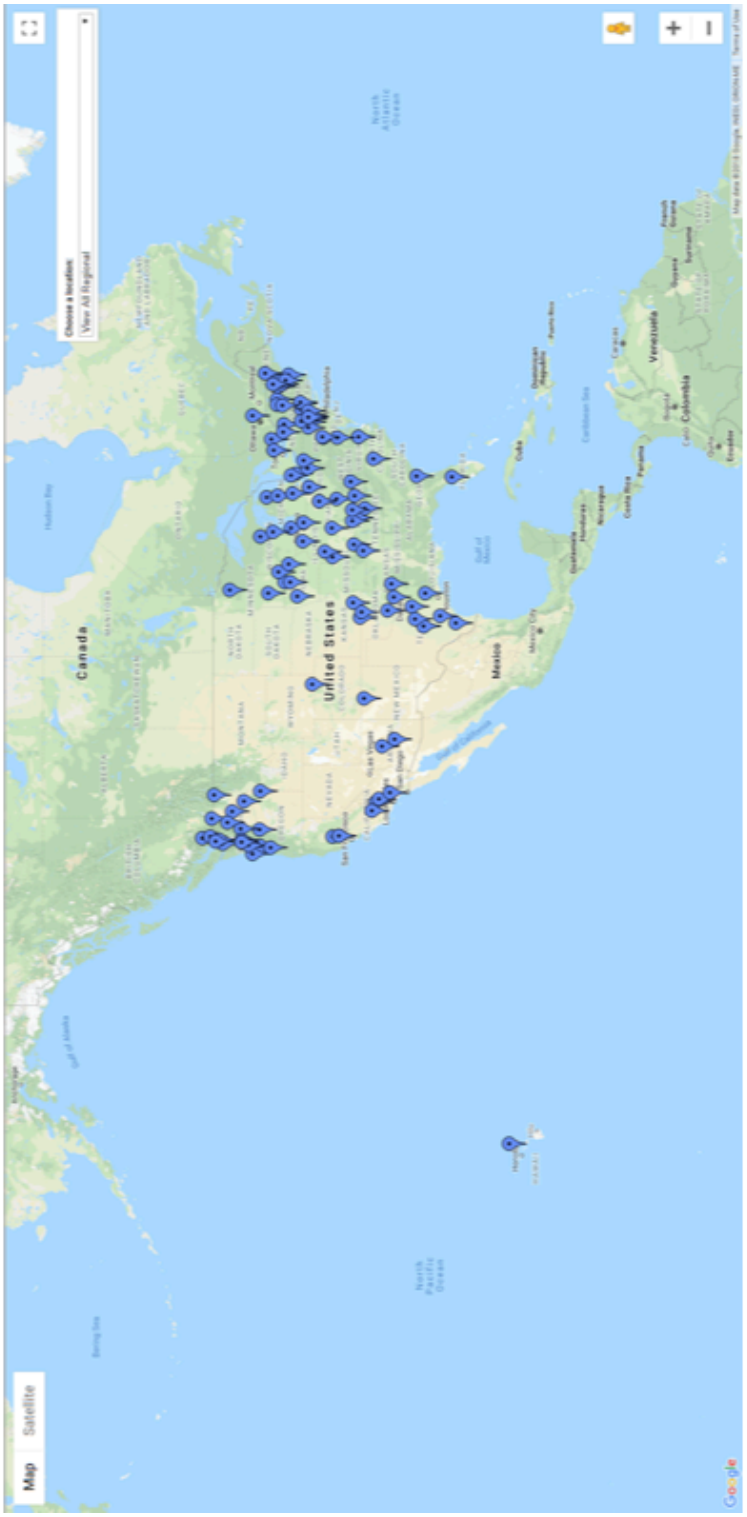
APPENDIX D: National STEM Networks



APPENDIX E: Statewide STEM Networks



APPENDIX F: Regional STEM Networks



APPENDIX G: Metro STEM Networks