December 1, 2017

MiSTEM Network Plan

Required by Section 99r of
Public Act 108 of 2017

Prepared for

The Governor and the Michigan Legislature

Department of Technology, Management and Budget

In order to view the full functionality of the report, we recommend that readers view it electronically.

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Executive Summary

History

The Governor's MiSTEM Advisory Council December 2016 report recommended rebranding the Michigan Mathematics and Science Centers (MSC) as Science, Technology, Engineering, and Mathematics (STEM) centers to drive regional STEM infrastructure. From this recommendation, Section 99r of Public Act 108 of 2017 directed the creation of the Michigan STEM (MiSTEM) Network as a systemic force to capitalize on educational outcomes in Michigan and ultimately improve students' preparation for an evolving workforce. The creation of the MiSTEM Network is led by the Transitional Executive Director (tED) and MiSTEM Committee. Legislation required that committee membership include representation of potential regional fiscal agents, General Education Leadership Network (GELN), Michigan Mathematics and Science Centers Network (MMSCN), Governor's Talent Investment Board (GTIB), and the Governor's MiSTEM Advisory Council (Advisory Council). The role of the committee is to advise the tED in selection of region boundaries, fiscal agents, staffing recommendations, and the creation of a statewide organizational Network plan.

The Plan

Public Act 108 of 2017 requires the development of a plan that requires the following items be submitted to the governor and legislature on or before December 1, 2017:

Section 99r (2)(a)(i): Creates a structured relationship between the MiSTEM Council, MiSTEM network executive director and executive assistant, and the MiSTEM network region staff.

The tED was hired in late August and immediately put into place the MiSTEM Committee. (See Appendix A for a complete list of committee members.) The MiSTEM Council advises the executive director on progress towards the four STEM pillars (see Figure 1) of the Advisory Council's report based on evidence gathered from the MiSTEM Network region directors. The region directors are critical voices that inform the statewide network of practice in the field. As requested by the legislature in statute, this report also establishes a structure for public and private partners to collaborate and makes staffing recommendations for each region. This is an opportunity to clearly define the structures and actors that need to be in place in order to transfer knowledge and build capacity within all areas of the state. It is an effort that will reimagine and restructure the education system so that the potential of every student is realized.

Section 99r (2)(a)(ii): Empowers the MiSTEM network regions in a manner that creates a robust statewide STEM culture, empowers STEM teachers, integrates business and education into the MiSTEM network, and ensures high quality and equitable distribution of STEM experiences for pupils.

The efforts of each region during the 2017-2018 fiscal year will focus on development of a strategic plan, per section 99s (7), that aligns with the vision of the four pillars presented in the Governor's MiSTEM Advisory Council December 2016 report. Appendix B includes specific region roles and responsibilities.

Section 99r (2)(a)(iii): Identifies region boundaries throughout the state and identifies fiscal agents within those regions.

The committee organized a grant competition for eligible fiscal agents that allowed local regions to come together and recommend region boundaries and fiscal agents to the committee. The committee reviewed these proposals and selected 16 regions to move forward in the proposal process. These 16 regions are outlined in Figure 2, and Appendix C includes the proposed fiscal agents and allocations per region. Each region was then asked to submit a proposal detailing how it will bring together partners in the region in a way that allows them to grow a robust STEM culture that ultimately provides STEM experiences for all students.

Section 99r (2)(a)(iv): Identifies MiSTEM state and regional goals and objectives and processes by which goals and objectives shall be measured: This item is under the duties of both the tED and the permanent ED (pED) whose tenure will begin in January 2018. This report establishes the groundwork for the regions to share in the responsibility for creating the goals, objectives, and processes by which the state will measure progress. The grant competition for the MiSTEM region boundaries and fiscal agents is the process provided to hold regions accountable to the tasks identified in section 99s (7).

Section 99r (2)(a)(v): Includes processes by which the MiSTEM network regions apply for MiSTEM grants, provide feedback on grant-funded programming, share best practices, and create regional master plans.

During the grant application and approval timeline for the 2017-2018 fiscal year, the tED participated in the development of the grant criteria and review process for the MiSTEM Advisory Council grants. This fiscal year, the MiSTEM Network regions will establish the priorities for their strategic plans and develop collaboratively with the pED the "MiSTEM state and regional goals and objectives and processes by which goals and objectives shall be measured" as outlined in Section 99r (2)(a)(iv) and Section 99r (3)(e).

Section 99r (2)(a)(vi): Creates a marketing campaign, including, at least, an on-line presence which includes dashboards of outcomes for the MiSTEM network. A MiSTEM website has been created to share general communication with the public about the formation and development of the MiSTEM Network. This is also part of the pED role as described in Section 99r (3)(b).

As a convening organization, the MiSTEM Network works to align efforts to capitalize on educational outcomes by grounding their efforts in best practices for teaching and learning. By activating passionate and committed networks of collaborators, clearly articulating a vision for teaching and learning, and aligning system components, Michigan will be a leader for the nation. This report sets forth that plan and the rationale for the resulting recommendations.

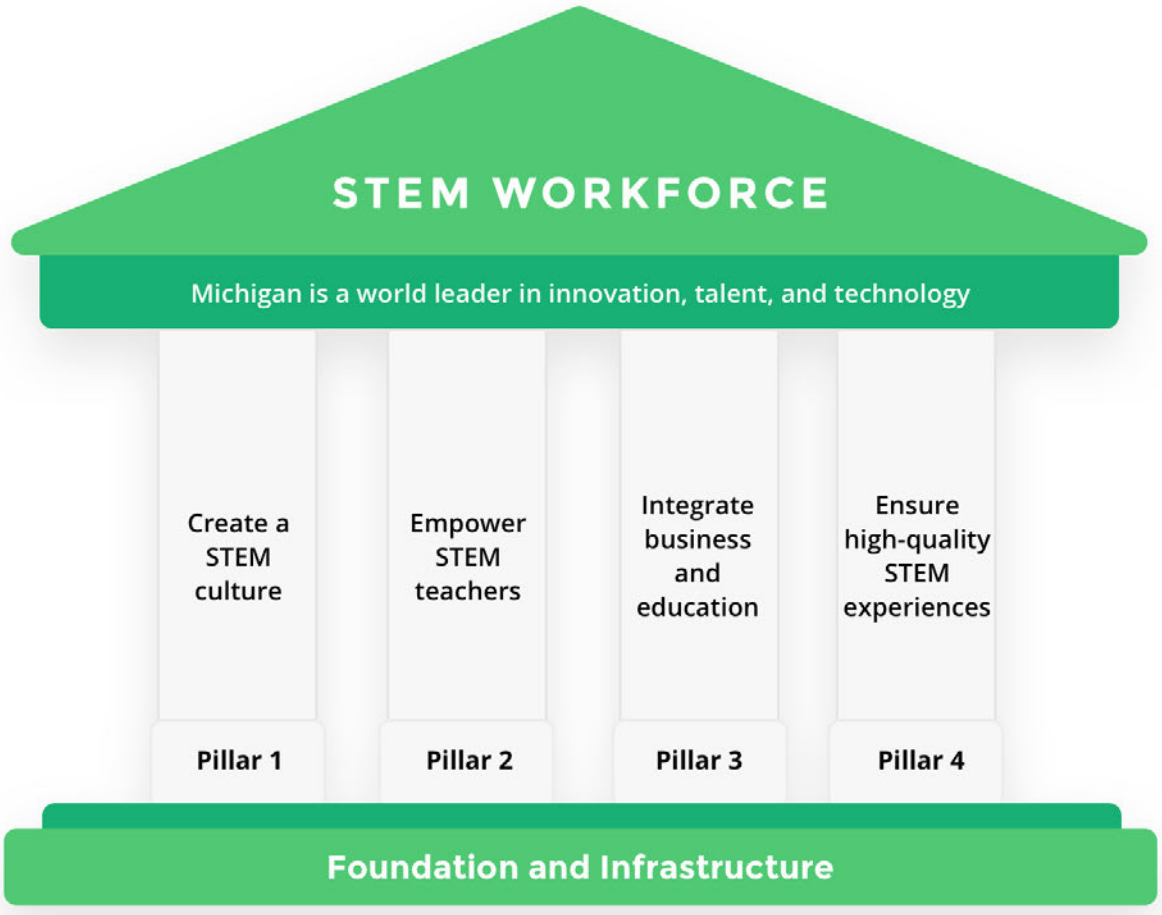

Figure 1. STEM Pillars

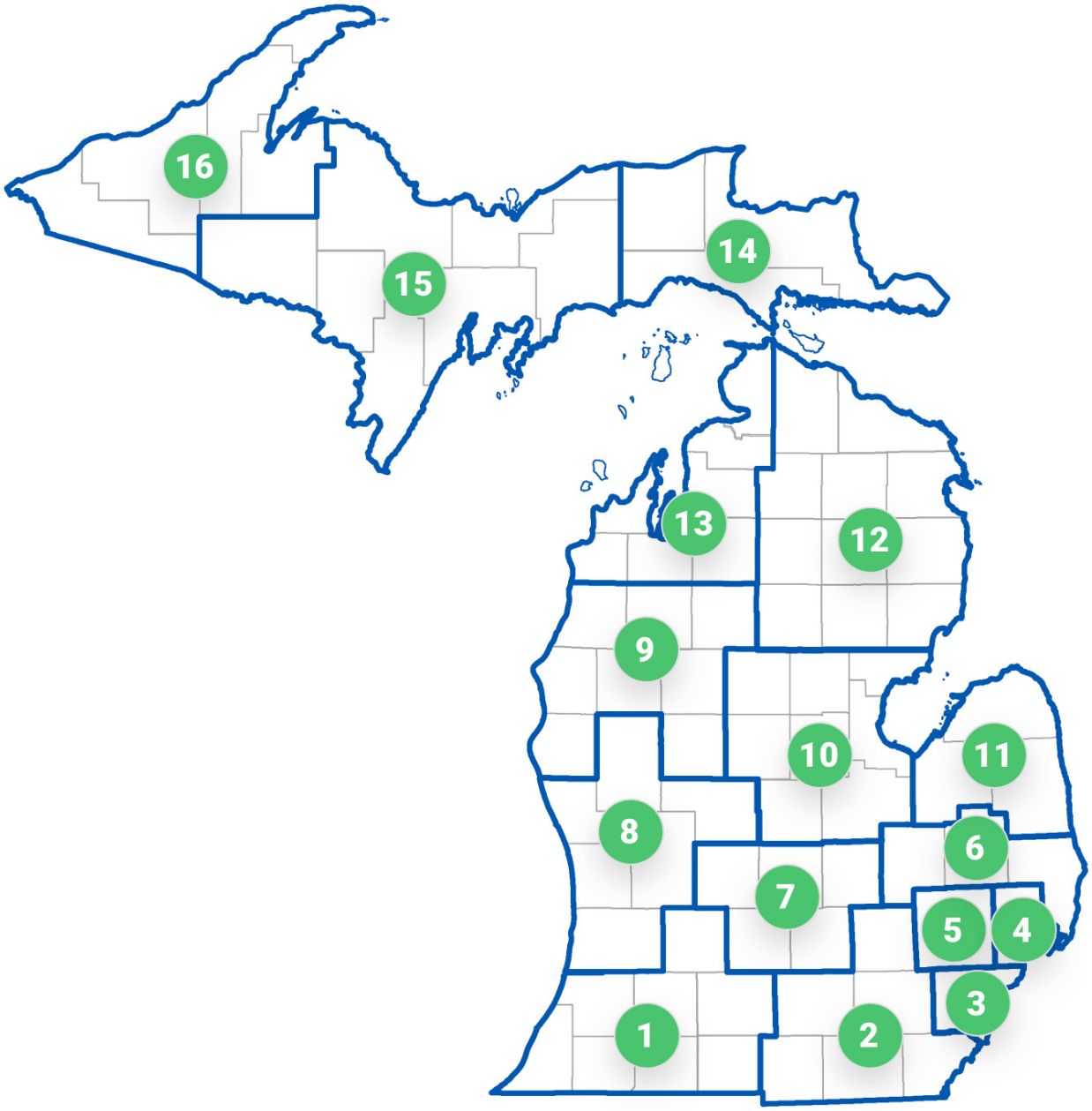

Figure 2. MiSTEM Network Regions

Background

To prepare students for the rapidly changing economy of the 21st century, Michigan is focused on reimagining a statewide education community support system with specific attention given to STEM. Public Act 108 Section 99s (12)(c) defines STEM as "science, technology, engineering, and mathematics delivered in an integrated fashion using cross-disciplinary learning experiences that can include language arts, performing and fine arts, and career and technical education." The committee recommends that STEM Literacy, STEM Education, STEM Schools, and STEM Careers as defined by the Michigan Mathematics and Science Centers Network (MMSCN) be included as a complement to the legislated definition (see Appendix D).

The Michigan Bureau of Labor Market Information and Strategic Initiatives (LMISI) reports STEM job opportunities in Michigan are growing at a faster rate than all other types of employment combined. According to official Long-term Occupational Employment Projections produced by LMISI, Michigan STEM occupations are projected to grow from an estimated 307,000 in 2014 to 348,000 by 2024. This 13.3% STEM job growth rate is nearly double the 7.4% expected for all jobs. Therefore, STEM jobs will account for roughly one out of every eight new jobs in Michigan during this period, expanding from an estimated 6.9% share of total jobs to about 7.3%.

To support the STEM workforce and vibrant, collaborative communities, the Governor's MiSTEM Advisory Council identifies four pillars (Figure 1) that will provide a strong foundation for guiding the work of the MiSTEM Network. The four pillars are 1) create a STEM culture, 2) empower STEM teachers, 3) integrate business and education, and 4) ensure high-quality STEM experiences (MiSTEM Advisory Council Report, 2016).

Support for the four pillars comes from the Michigan Department of Education's (MDE) Top 10 in 10 focus areas: learner-centered supports, an effective education workforce, strategic partnerships, and systemic infrastructure. In order for systemic improvement to take place, intentional connections and collaborative partnerships must be fostered (Top 10 in 10 Years Strategic Plan, 2015). Michigan's Every Student Succeeds Act (ESSA) Plan uses a student-centric model, leverages resources to assist education organizations, targets support to where it is most needed, and

evaluates outcomes related to test scores, safety, well-being, access, and quality of experience. Additionally, the Michigan Career Pathways Alliance is designed to help improve student access to career pathways and help students be better prepared to enter the workforce--all in an effort to narrow the talent gap and continue to build a stronger talent base in Michigan.

While not all job opportunities are considered STEM careers, the problem solving, communication, and critical thinking attributes that students develop by engaging with STEM problems are critical elements of the Michigan K-12 Academic Standards

Career and College Ready Characteristics, which are necessary competencies for all students. Michigan's Top 10 in 10 strategic plan, the state ESSA plan, the Governor's 21st Century Education Commission report, and the Michigan Career Pathways Alliance are four key examples that showcase the timeliness and necessity of the work that the MiSTEM Network is tasked with. Therefore it is incumbent upon the MiSTEM Network and the committee to generate solution-oriented recommendations as well as a vision for sustainable STEM pathways and careers for students from pre-K to 20.

MiSTEM Network Vision

The MiSTEM Network vision is that every student experiences phenomenon- and problem-based learning that intentionally promotes connections to the socio-cultural contexts in which they live and grow. In order to realize the four pillars of the Advisory Council report, as well as the charges placed before the state in legislation, the MiSTEM Network will provide the space to convene and mobilize a multitude of collaborators throughout the entire system, including but not limited to parents/families, faith-based organizations, not-for-profits, and mental health organizations. The intent of the collaboration is to focus on preparing all students for the world they live in now and for the future. This work is critical to the continued growth of vibrant communities across our state. Figure 3 attempts to clarify how the work will move forward in order to meet the vision. It also communicates what must be accomplished in order to realize a fundamental shift in practice for the entire system.

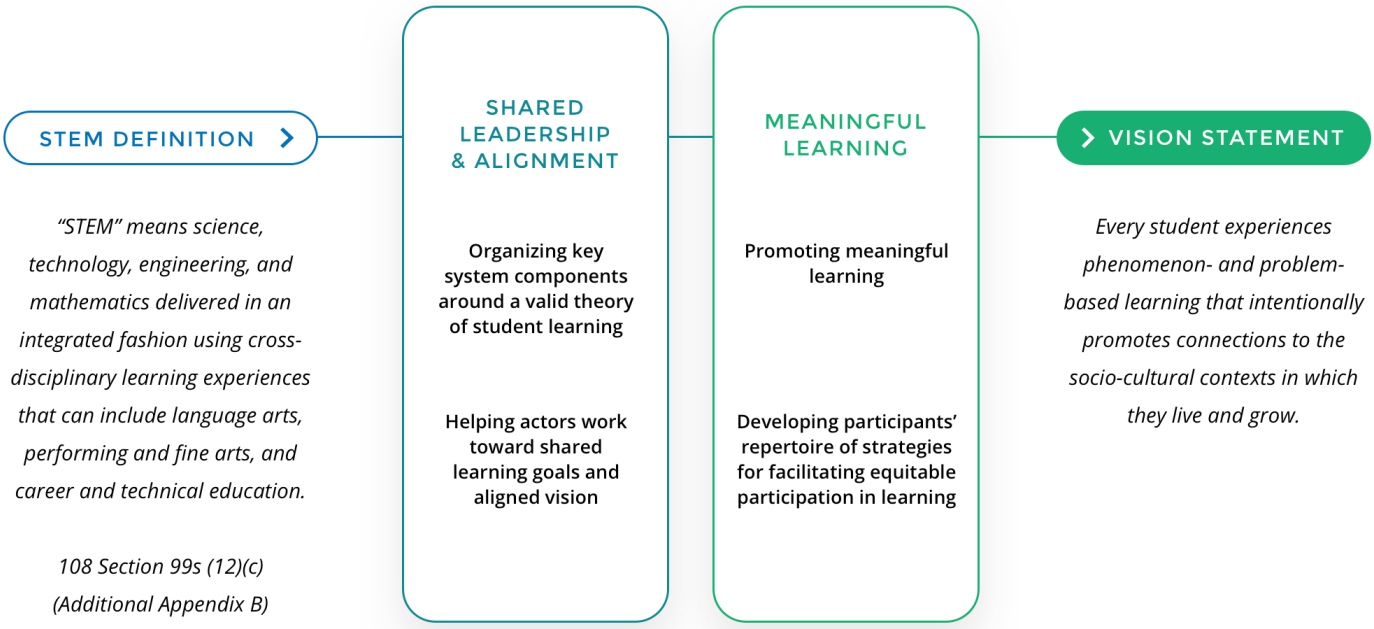

Figure 3. MiSTEM Network Vision

The primary driver for change in our system is the STEM definition in Public Act 108 Section 99s (12)(c). In addition, section 99s (1) says that "[p]rograms funded under this section are intended to increase the number of pupils demonstrating proficiency in science and mathematics on the state assessments and to increase the number of pupils who are college- and career-ready upon high school graduation." The MiSTEM Network fully embraces this charge and has therefore used the 4th pillar of the MiSTEM Advisory Council report (ensure high-quality STEM experiences) to inform the MiSTEM Network vision statement. The vision is grounded in the most recent research on teaching and learning and reflects the type of learning experiences called for in the legislature's STEM definition and the MiSTEM Advisory Council report. This vision also serves as our claim for the types of experiences that will produce the outcomes described in legislation.

The work of the MiSTEM Network collaborators is rooted in the Advisory Council's four pillars and requires shared leadership and alignment while promoting meaningful learning. Currently, the development of the MiSTEM Network is a necessary step towards the first part of shared leadership and alignment--organizing key system components. For this initial step it is critical to focus on building strong relationships and communication practices to move the common vision forward.

MiSTEM Network Development Process

Per Section 99r (2)(a)(ii), the MiSTEM Network plan must empower its regions to create a state-wide system that aligns with the MiSTEM Council's four pillars. Section 99r (2)(b) also charges the tED with the formation of a committee that is responsible for:

1. Identifying each network region
2. Selecting a fiscal agent for each region
3. Determining staffing for each region
4. Determining the processes by which the entire region will receive and share services

The MiSTEM committee determined that a two-phase competitive grant program would be put forth in an effort to allow regions throughout the state to reorganize and determine initial region boundaries. The intent of the competitive grant program was for entities to showcase their strengths, partnerships, and rationales for new regional boundaries. In addition, this recognized the regions as the experts in their area of the state and allowed them to present a case to the committee that their proposed boundaries and fiscal agent would provide the best possible service for that community. The committee is pleased to report that after the first phase of the grant process, 16 regions self-identified across the state with no overlapping boundaries or vacant service areas. The final list of proposed fiscal agents includes 13 Intermediate School Districts (ISDs) and three universities. This new fiscal representation for the MiSTEM Network fulfills a need to bring differing perspectives, resources, and talents forward to advance initiatives, and it reflects the cross-disciplinary work that should be fostered in student practice.

The second phase of the application process required letters of support from a multitude of collaborators in each proposed region, a commitment to data collection and sharing of best practices, a plan of work to meet the requirements in Sections 99s(6) and (7) (summarized below in Appendix B), and a budget that supports that plan of work. Part of the enactment of the four pillars towards the MiSTEM vision rests upon a development or creation of a regional ecosystem in which all collaborators have roles and responsibilities that move educational experiences in STEM towards future goals. When the MiSTEM Network uses the word ecosystem, it refers to the organic interaction of varied collaborators. The committee proposes that the regions advance as

flexible ecosystems that are able to create and respond to changing needs of the region or the state. Approval of phase two proposals will release funds to the regions and provide monitoring checkpoints for the pED as the regions develop their ecosystems and align their strategic plans to the MiSTEM four pillars.

The recommended regions and corresponding fiscal agents for 2017-2018 MiSTEM Network funds are shown in Figure 2. Appendix C shows the allocations for each MiSTEM Region in 2017-2018.

This new map shows how the 33 Mathematics and Science Centers, ISDs, and universities are re-organized into 16 MiSTEM Regions. Our next step will be to build a professional network across these regions which will dramatically transform the way teaching and learning is delivered and consumed. Research on networked improvement communities shows that social relationships provide important pathways for information exchange and knowledge-sharing (Bryk et al., 2015). Increasingly, educational systems are turning towards cross-institutional social networks as critical infrastructures to collectively solve problems of practice and disseminate new ideas. Rather than focusing on educators' individual attributes, this perspective emphasizes the importance of educator interactions and professional collaboration as a fundamental system resource for educational improvement and innovation. In this spirit, the tED has gathered data on the existing networks within Michigan to explore patterns of interaction amongst STEM educators and resource providers and then collaborated with a Michigan State University research team that specializes in network analysis and network interventions. The data collected provides a baseline network structure for developing strategies for improvement and tracking MiSTEM progress. Network analysis also enables a fine-grained assessment of progress towards pillar three--the integration of business and education--by showing how relationships form between STEM educators and the business community. Network visualization and analysis will provide an evidence base for determining how to intervene at the state level when implementing new programming or evaluating regional relationships. The current network of STEM connections in Michigan is provided in Appendix E with the accompanying analysis.

MiSTEM Network Structure

The MiSTEM Network is responsible for creating a structure for shared leadership and responsibility between organizations, community, and business leaders interested in establishing Michigan as a leader in STEM education. The MiSTEM Network is a state and regional support structure that will leverage public and private partnerships to elevate STEM education. It is the convening and collaborating space for the key system components referenced in Figure 3. The purpose of the MiSTEM Network is to ultimately provide STEM learning experiences for all students. To assure that all students have the opportunity to engage in STEM learning experiences, it is important to establish partnerships between classroom educators and community partners. Classroom educators need to be exposed to STEM learning experiences that community partners have the expertise to provide. It is through collaboration with community partners that classroom educators will expand their knowledge of STEM experiences and develop their understanding of how STEM learning experiences can be integrated within their instruction. To do this, clarification is needed about the components that make up the entire system of supports so that students and classroom educators are surrounded by STEM experiences in and out of school.

The shared leadership model of the MiSTEM Network regions will allow access to multiple STEM experts who can work both regionally and statewide. This will empower regional partners to provide STEM resources and supports for individual schools. By aligning the system components in this way, students in every community will have the opportunity to learn.

Per Section 99r(2)(a)(i): The tED "[c]reates a structured relationship between the MiSTEM council, MiSTEM network executive director and executive assistant, and MiSTEM network region staff that ensures services to all regions and local communities in each region." Figure 4 represents this structured relationship as a shared leadership and responsibility framework between the governing arms of the structure and the collaborating MiSTEM region partners.

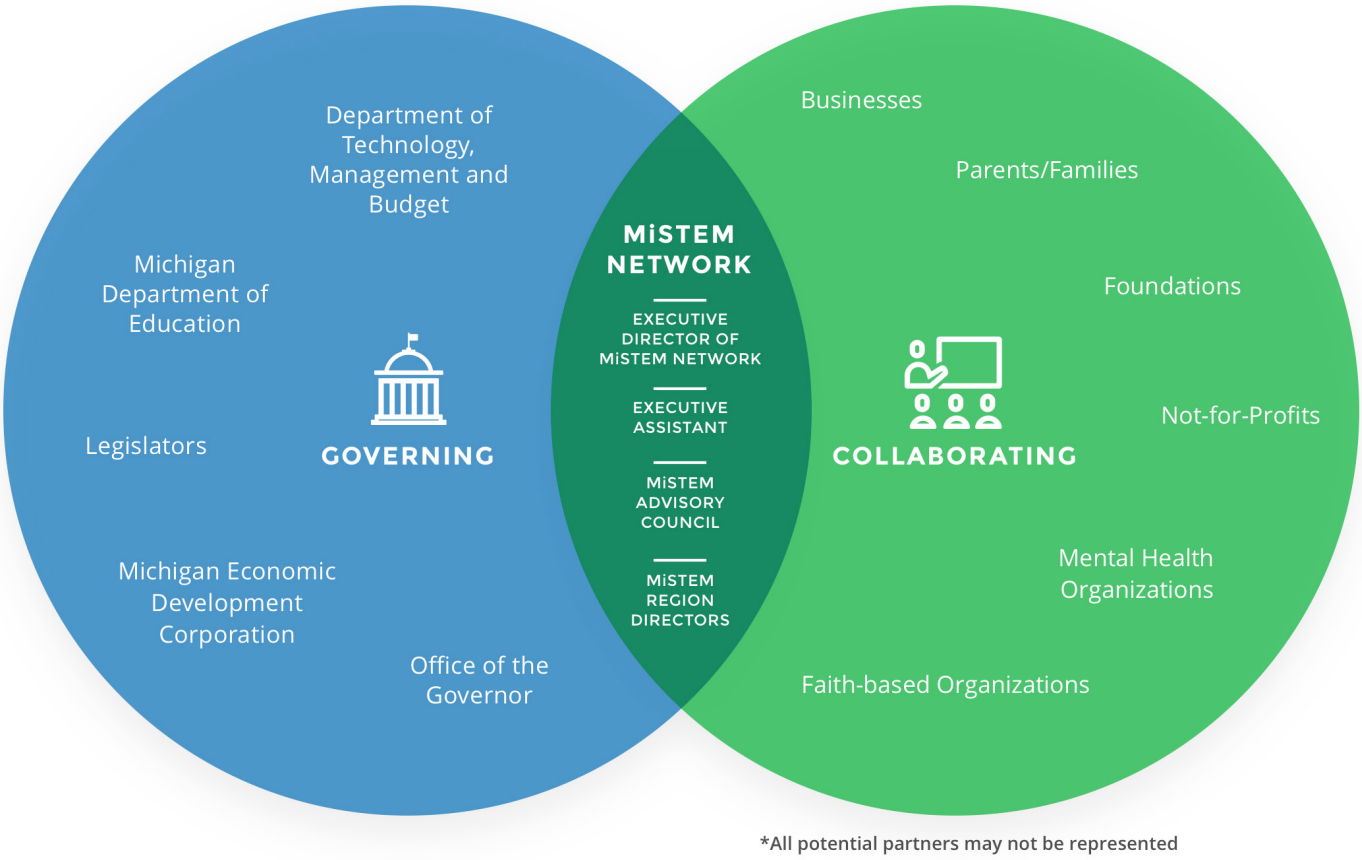

Figure 4. MiSTEM Network Structure

The Executive Director and Executive Assistant are part of the intersection of the governing and collaborating arms because of the responsibilities of managing and granting funds to the regions, monitoring and evaluating the success of the regions, and coordinating messages from the Government and the Advisory Council. The Advisory Council on the other hand is a governing body for the Executive Director, but also has duties per legislation that situates them as collaborators.

The same is true for the Region Directors. They will have governing responsibilities within their region, but in the overall MiSTEM Network they will have a collaborating role. The Region Directors (as both MiSTEM state and regional staff) will establish a structure for governance and collaboration that mirrors the overall state network. This is crucial for empowering all partners

invested in STEM so that they share in the development of the regional STEM culture and grow in capacity to collaboratively provide STEM experiences. The collaborators are critical to inform the application of policies and theories in practice so that the governing bodies receive accurate and timely data. Again, the overall collaborative nature of the MiSTEM Network is a reflection of the multi-expertise teams with whom students should be capable of working. As educational, community, and business leaders, it is important to model these practices for students. This structure will grow a strength-based coalition that allows for inquiry building and rapid prototyping through a shared leadership and responsibility mindset.

Staffing Considerations

The following section delves into the various leadership and capacity building roles that collaborators must implement to provide STEM experiences for students and evaluate how students respond to these efforts. Our educational system must build on the current capacity achieved through the MMSCN for STEM (at least 33 math or science professional learning providers) and continue to grow the leadership pool that will support the entire state in shifting practices to achieve desired outcomes. The goal is to create a more efficient and effective way for the MiSTEM region partners to collaborate by aligning the work and service levels that are in place currently. Therefore, our proposal is that the MiSTEM staff is comprised of the Region Directors, the state permanent Executive Director, and state Executive Assistant. Their responsibilities would entail bringing the regional partners together as collaborators to identify and work towards a common vision. These directors should be additional staff beyond what is currently in existence and would require at a minimum 16 full-time positions across the state. In order to further the MiSTEM development process, it is necessary to understand the current capacity for regions to provide STEM learning experiences. It is impossible at this time to make a staffing recommendation beyond the Director level for individual regions without knowing the available assets that already exist. Asset mapping, completed over fiscal year 2017-2018, will allow the MiSTEM Advisory Council and pED to make evidence-based staffing recommendations. As a possible solution to the staffing issue, the School Finance Research Collaborative releases their report in early 2018. However, included in this report is one possible way to calculate the amount of Professional Learning Providers (PLP) and Instructional Coaches (IC) needed in one year to work with every classroom educator on one instructional shift or program. This snapshot will provide the state with a formula or baseline process for staffing programmatic efforts in a way that can be adjusted as needed.

Master STEM Educators

Communicating and establishing a master STEM educator ecosystem has important implications for developing and retaining Michigan's resources for STEM education. This master educator ecosystem is depicted in Figure 5 below.

First, mapping the educator ecosystem will help collaborators (i.e. parents/families, faith-based organizations, not-for-profits, mental health organizations, etc.) articulate their role in an initia-

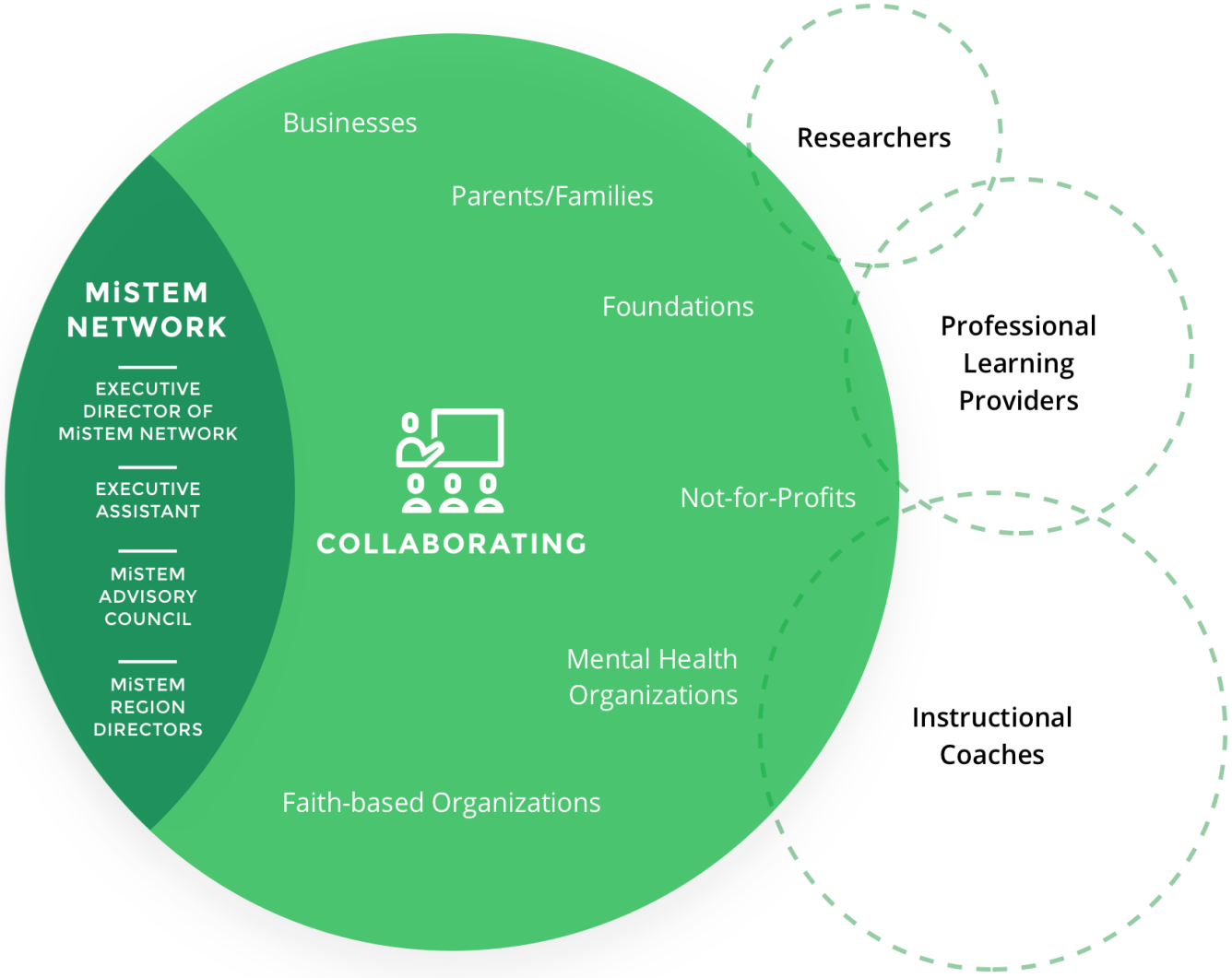

Figure 5. Master Educator Ecosystem

tive, improving their efficiency and effectiveness. Second, defining and promoting alternative professional paths in education aims to recruit and retain STEM teachers, content specialists, and administrators. This approach is designed to address the inaccurate belief that a career in education only yields two options--classroom teacher or administrator. Research shows that fostering a professional environment for teachers that provides them with opportunities for instructional leadership improves teacher quality and retention (Ingersoll, 1997; Waddell, 2010). Research also indicates that teacher-leaders are a credible source of professional development to their peers and that formal leadership roles reinvigorate the careers of experienced teachers (Abbott & McKnight, 2010; Taylor et al., 2011). Altogether, creating a system that incentivizes educators to remain in Michigan and seek educational opportunities for advancement within the system rather than to seek external opportunities is critical.

The overall number of individuals entering the educator workforce in Michigan through initial certification has been decreasing since 2004. Trends in Michigan teacher certification and teacher turnover are evident in these two white papers from the Michigan Department of Education (Robinson and Lloyd, 2017; Stackhouse, 2017). Endorsements for certification areas that school administrators cite as hard-to-staff content areas, including STEM, have declined significantly over the last five years, further limiting supply in these areas. Among staffed educators, the stability rate (the rate at which teachers remain in the same position) in the state is lower than that nationally, with much of the gap attributable to teachers moving between schools at higher rates. These higher rates of mobility, in addition to attrition, create substantial costs for schools, districts, and ISDs. Evidence from the Michigan Department of Education's teacher turnover research suggests that mobility rates are higher for STEM educators than for most other subject areas in Michigan. Lastly, along with all of these dimensions--certification, staffing, and mobility/attrition--Michigan demonstrates significant disparities between white and nonwhite educators. Comprehensive considerations must be spent on how to recruit and train new educators, how to retain the current educators, as well as to undertake an examination of what is driving racial disparities across the system. In particular, pursuing strategies to ensure educator demographics are reflective of the student demographics in the region may help address racial inequality. This practice has been shown to improve student outcomes across all demographics (Dee, 2005). Table 1 summarizes the student demographic breakdown in each region so that regions may begin thoughtful efforts to address disparities across the system.

Table 1. MiSTEM Network Region Demographic Profile

Region Number	Fiscal	Percent American Indian	Percent Asian	Percent African American	Percent Hispanic	Percent Hawaiian	Percent White	Percent Two or More Races/Ethnicities
1	Kalamazoo RESA	0.42%	1.86%	12.77%	10.12%	0.09%	68.92%	5.83%
2	Washtenaw ISD	0.36%	3.07%	8.53%	5.63%	0.09%	78.19%	4.14%
3	Wayne RESA	0.24%	3.74%	40.71%	8.21%	0.06%	44.94%	2.10%
4	Macomb ISD	0.24%	4.11%	18.21%	3.42%	0.15%	69.49%	4.39%
5	Oakland Schools	0.21%	8.19%	20.40%	5.90%	0.09%	62.02%	3.19%
6	Genesee ISD	0.36%	0.77%	17.59%	4.66%	0.07%	72.33%	4.23%
7	Shiawassee Regional ESD	0.35%	3.36%	10.30%	8.53%	0.08%	72.26%	5.12%
8	Grand Valley State University	0.35%	2.63%	9.77%	14.47%	0.09%	68.57%	4.12%
9	West Shore ESD	0.85%	0.57%	3.46%	8.13%	0.10%	83.25%	3.64%
10	Saginaw Valley State University	0.97%	1.35%	11.27%	7.23%	0.14%	76.44%	2.60%
11	Huron ISD	0.39%	0.41%	1.60%	4.05%	0.08%	92.41%	1.06%
12	Alpena-Montmorency-Alcona ESD	0.77%	0.54%	0.77%	2.09%	0.06%	92.91%	2.85%
13	Traverse Bay Area ISD	2.40%	1.03%	0.83%	3.67%	0.08%	88.84%	3.14%
14	Eastern Upper Peninsula ISD	35.83%	0.80%	1.82%	0.98%	0.15%	58.81%	1.63%
15	Northern Michigan University	4.18%	0.42%	0.54%	1.87%	0.13%	88.96%	3.90%
16	Copper Country ISD	4.72%	1.24%	0.55%	0.93%	0.07%	89.38%	3.13%

Data source: Data were pulled from the MiSTEM Network GIS map which compiles data from the Education Entity Master.

The MiSTEM Network, through the creation of an ecosystem that empowers STEM educators, will be a catalyst to change the data points listed above and contribute to the research base surrounding leadership development in educators. From a recent National Academies consensus study led by Suzanne Wilson on Science Teachers' Learning, research suggests that the literature is lacking in "studies of how teachers learn to become leaders, as well as research that examines the role, expertise, or preparation of science professional development providers and facilitators" (National Academies of Sciences, Engineering and Medicine, 2015). The master

STEM educator ecosystem provides a mechanism for communicating to interested and practicing collaborators the varying leadership roles and responsibilities that are required for a fully functioning system.

The MiSTEM Network committee suggests the descriptor "teacher" used in the four pillars be replaced with "educator" so community collaborators such as parents/families, faith-based organizations, not-for-profits, mental health organizations, etc. will also identify with the roles within the ecosystem. In this view, every collaborator has a specific purpose in supporting the ecosystem that makes up the MiSTEM Network and each purpose requires different professional learning (PL). Therefore, each role in the ecosystem also needs to be supported in appropriate phenomena- and problem-based learning that intentionally promotes connections to the socio-cultural contexts in which they live and grow. As education researcher Michael Fullan stated, "[t]he purpose of staff development is not just to implement instructional innovations; its central purpose is to grow strong collaborative work cultures that will develop the long term capacity for change" (Fullan, 1993).

It is important to recognize that collaborators may serve in multiple roles simultaneously, not just at different times in their careers. The ecosystem model provides a mechanism for a robust feedback loop by including all members of the ecosystem in the rollout of new initiatives. Therefore, it provides a path forward in determining staffing levels when changes need to be made in STEM learning experiences. However, as mentioned above, until an internal scan of community collaborators already in existence in the ecosystem can be completed, staffing levels will fluctuate and a solid recommendation will be hard to make for the regions.

This ecosystem presents an alignment of system components that will serve to help the system function more efficiently at the regional and state levels, but also to empower STEM teachers and grow a robust culture of STEM through the integration of business and education collaborators. Per legislation Sec. 99r(2)(a)(ii), the structure "[e]mpowers the MiSTEM network regions in a manner that creates a robust statewide STEM culture, empowers STEM teachers, integrates business and education into the MiSTEM network, and ensures high-quality and equitable distribution of STEM experiences for pupils."

MiSTEM Network Programmatic Staffing Formula

This section includes one possible way to calculate the staffing levels (beyond the Region Director) needed per region to provide professional learning for every classroom educator in one program per year. This formula might be used in regions or across the state when applying for grant funds for specific programmatic efforts. The staffing level estimate and formula are provided for each region in Table 2. Appendix F explains in detail the formula development and the inputs used.

Calculating staffing is not an exact science. It is possible that the staffing positions recommended draw from the collaborators that exist within the overlapping regions of the master STEM educator ecosystem. While it is quite beneficial for a PLP to also be the IC, at times this is not feasible. Some possible ways to adjust the calculations presented would be to take the numbers in Table 2 and multiply by two--to allow for more people to essentially have fewer days to devote solely to one program and to change the timeline to extend beyond one year for these services. Additional considerations that are not factored into this calculation are assumptions that there will be no problems with scheduling events and that the distance that PLP and IC need to travel in order to provide services does not change the amount of time available for work. This calculation also assumes that there is adequate substitute coverage and release time for teachers in their districts to allow for the recommended PL time. Adequate staffing levels would insure that all teachers in a region are served despite the logistical challenges that will arise. Appendix F contains a detailed description of the calculation rationale for staffing initiatives and servicing regions.

Table 2. Recommended Minimum Staffing

Region Number	Proposed Fiscal Agent	Region Director	Number of Professional Learning Providers [a,c]	Number of Instructional Coaches [b,c]
1	Kalamazoo RESA	1	21	88
2	Washtenaw ISD	1	23	96
3	Wayne RESA	1	45	189
4	Macomb ISD	1	21	91
5	Oakland Schools	1	30	128
6	Genesee ISD	1	17	70
7	Shiawassee Regional ESD	1	15	62
8	Grand Valley State University	1	36	151
9	West Shore ESD	1	5	21
10	Saginaw Valley State University	1	13	53
11	Huron ISD	1	3	13
12	Alpena-Montmorency-Alcona ESD	1	4	17
13	Traverse Bay Area ISD	1	5	21
14	Eastern Upper Peninsula ISD	1	1	5
15	Northern Michigan University	1	4	16
16	Copper Country ISD	1	1	6
Total	State of Michigan	16	244	1027

**All minimum staffing levels were rounded to the nearest whole number*

*a) Minimum number of Professional Learning Providers estimated as follows: (Estimated Number of Teachers*40 hours per teacher)/15 teachers per PLP day)/6 hours per PLP day/ PLP 90 days)*

*b) Minimum number of Instructional Coaches estimated as follows: (Estimated Number of Teachers*40 hours per teacher)/4 teachers per coaching day/6 hours per coaching day/80 coaching days per year)*

c) Data source: Data were pulled from the MiSTEM Network GIS map which compiles data from the Education Entity Master.

Governance Requirements and Funding for Regions

The Michigan legislature asked for a report on the "processes by which the MiSTEM network regions apply for MiSTEM grants, provide feedback on grant-funded programming, share best practices, and create regional master plans" (Section 99r (2)(a)(v)). While some of this legislation has been addressed above, this work is expected to be completed by the MiSTEM Advisory Council in collaboration with the permanent Executive Director as described in Section 99r (3)(c) and (f) and Section 99s (2)(e) and (3). During the grant application and approval timeline for the 2017-2018 fiscal year grants, the tED has participated in the development of the grant criteria and review process for the MiSTEM Advisory Council grants. However, since the timeline to recommend funding for these programs directly overlaps with the MiSTEM Network development process, the region fiscals were not able to apply. Therefore collaborators within the regions have been encouraged to apply during the MiSTEM Network's introductory year. Over the course of this fiscal year the MiSTEM Network regions will come together to establish the priorities for their strategic plans and develop, collaboratively with the pED, the "MiSTEM state and regional goals and objectives and processes by which goals and objectives shall be measured" as outlined in Section 99r (2)(a)(iv) and Section 99r (3)(e). The following section describes completed work so far and captures the baseline state of the MiSTEM Network and the processes by which progress towards the four STEM pillars will be measured.

Data Monitoring/Evaluation

Per Section 99r (2)(a)(vi), the tED will create "a marketing campaign, including, at least, an online presence which includes dashboards of outcomes for the MiSTEM network." This is also part of the permanent Executive Director role as described in Section 99r (3)(b). As previously referenced, a MiSTEM website has been created to share general communication with the public about the formation and development of the MiSTEM Network. A critical monitoring function included on the website is a GIS application that will be updated annually from other State of Michigan databases to provide timely sources of information about region student demographics, locations and numbers of educational entities, as well as locations and numbers of STEM employers and jobs (MiSTEM Network Map, 2017). It is also important to consider the less-referenced data sources that directly and indirectly link to student achievement. One source is the formation of the MiSTEM Network and whether the Network is connecting more partners through the shared leadership model as monitored through the work described in Appendix E. A substantial body of research shows that professional networks provide educators with access to critical resources that improve teaching, such as knowledge about local practices, access to collaboration and sensemaking around instruction, and information about instructional innovations. Currently there are educator connections in the network visualization, but this approach will eventually help us to measure business and education integration as well. Other crucial variables discussed above are teacher mobility and demographic information. If STEM educators are empowered, then there should be an increase in the number of certifications from diverse populations as well as a decrease in mobility rates. These advancements would indicate that educators are invested and empowered in the work that they are doing and see multiple pathways for leadership and growth in an education career as described in the master STEM educator ecosystem depicted in Figure 5. These data points are especially important from a fiscal responsibility standpoint. Continual educator turnover means the work will not be implemented or sustained in a way that will provide the academic outcomes intended.

Measurement of STEM experiences will be gathered primarily through a relationship with the Section 22m funded Michigan Data Hub, for which CEPI is the granting authority, and through independent evaluators. The primary focus of the Data Hub and the MiSTEM Network data

collection will be student participation with access to accompanying achievement data. The MiSTEM Network plans to have schools track student participation and sign data-sharing agreements that would allow evaluators to mine the data across all participants. This would allow the Data Hub to cross reference and research the impact of MiSTEM Network participation. Available information would include student grades, attendance, behavior, state assessment, and other assessment data. This data will of course be de-identified to maintain student privacy.

The Data Hubs also offer the ability to award or endorse digital badging. Using digital badging and the eventual development of a Talent Transcript system would allow for STEM events, participation, and demonstrated efforts to be catalogued, maintained, and shared with students, colleges, and potential employers. This collaboration with an already established effort in Michigan provides an example of how the MiSTEM Network will work to align resources and efforts that are already in existence. These sorts of collaborations will improve efficiency and benefit each collaborator.

Summary

This report serves as a reminder that the four STEM pillars do not work in isolation from each other, but instead operate as an integrated vision of STEM. In fact, all components of the MiSTEM Network plan discussed in this report work together to build a robust STEM culture in our state that is focused on providing STEM learning experiences that not only move forward workforce talent development, but also significantly contribute to the vibrancy and vitality of our communities. Enacting the four pillars will require many people in many different parts of the system to redefine and transform their beliefs about teaching and learning, as well as their professional roles, relationships, and collaborative practices. When one seeks to transform the system, not tweak it, it is no small task. In fact, enacting the vision promises to be one of the most ambitious educational change agendas to date in the state of Michigan. As MIT systems change expert Peter Senge points out, to transform the system we must change our own mind-sets—our own mental models. Such transformative learning and organizational change 1) does not happen overnight, thus requiring commitments to experiment, make mistakes, learn from mistakes, and stay the course over a period of many years, 2) requires the formation of high levels of trust in a system that currently is structured around competition for resources, 3) must be driven by teachers at a time when teachers feel they have little power, and 4) must be adequately resourced to succeed.

The challenges before us are many, but the potential and motivation for us to collectively meet these challenges has never been greater. The work of the MiSTEM Network is critical to support each region by lifting up and sharing best practices across the state to provide learning opportunities for all. Our plan is to build on the collaborative foundation established by the MMSCN and encourage the growth of shared leadership and responsibility across the state. While it cannot be known exactly which experiences will inspire students or community educators to take their work to the next level, providing the support structure for STEM learning to take place increases our chances to do so. In-depth, substantive experiences for all will get us to our goals.

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Appendices

Appendix A--MiSTEM Committee Membership

Appendix B--Region Roles and Responsibilities

Appendix C--MiSTEM Network Region Allocations

Appendix D--MMSCN STEM Definitions

Appendix E--Visualization of Current STEM Networks in Michigan

Appendix F--Programmatic Staffing Calculations

Appendix G--Glossary of Acronyms

Appendix A

MiSTEM Committee Membership

Name	Role	Affiliation	Fiscal Representation
Kathleen Bushnell Owsley	Governor's MiSTEM Advisory Council	Executive Director, Bosch Community Fund	
Christian Velasquez	Governor's MiSTEM Advisory Council	Global Market Director, Dow Corning Corporation	
Jodi Redman	MI Mathematics and Science Centers Network	President, MMSCN and Wexford-Missaukee ISD	MMSCN
Mary Starr, PhD	MI Mathematics and Science Centers Network	Executive Director, MMSCN	MMSCN
Michelle Ribant	Michigan Department of Education	Assistant Director, Office of P20 Data and Information Management	
Joanne Hopper, EdD	General Education Leadership Network	Director, GELN	Intermediate School Districts
Kathleen Miller	General Education Leadership Network	Past-Chair, GELN and Shiawassee RESD	Intermediate School Districts
George G. Stockero, Jr.	Michigan Association of Intermediate School Administrators	Superintendent, Copper Country ISD	Intermediate School Districts
Joe Krajcik, PhD and Chris Reimann, PhD	University	Director, Create for STEM, Michigan State University	University
Jacqueline Huntoon, PhD	University	Provost, Michigan Technological University	University
Lee Graham	Governor's Talent Investment Board	Operating Engineers 324, Executive Director, LMEC	
Marilyn Moran	Governor's Talent Investment Board	V.P. of Sales & Marketing Moran Iron Works, Inc.	
Megan Schrauben	Transitional Executive Director, MiSTEM Network	MI Department of Technology, Management, and Budget	
Ashley Bieniek-Tobasco, MPH	Executive Assistant, MiSTEM Network	MI Department of Technology, Management, and Budget	

Appendix B

Region Roles and Responsibilities

1. The MiSTEM advisory council is encouraged to work with the MiSTEM Network regions to develop locally and regionally developed programs and professional development experiences for the programs on the list of approved programs. (Section 99s (2)(g))
2. Each grant recipient shall collaborate with the talent district career council that is located in the prosperity region to develop a strategic plan for STEM education that creates a robust regional STEM culture, that empowers STEM teachers, integrates business and education into the STEM network, and ensures high-quality STEM experiences for pupils. (Section 99s (7))
    a. At a minimum, a regional STEM strategic plan should do all of the following:
        i. Identify regional employers' need for STEM.
        ii. Identify processes for regional employers and educators to create guided pathways for STEM careers that include internships or externships, apprenticeships, and other experiential engagements for pupils.
        iii. Identify educator professional development opportunities, including internships or externships and apprenticeships, that integrate this state's content standards into high-quality STEM experiences that engage pupils.

    b. Facilitate regional STEM events such as educator and employer networking and STEM career fairs to raise STEM awareness.

    c. Contribute to the MiSTEM website and engage in other MiSTEM network functions to further the mission of STEM in this state in coordination with the MiSTEM Advisory Council and its executive director.

    d. Facilitate application and implementation of state and federal funds under this subsection and any other grants or funds for the MiSTEM network region.

    e. Work with districts to provide STEM programming and professional development.

    f. Coordinate recurring discussions and work with the talent district career council to ensure that feedback and best practices are being shared, including funding, program, professional learning opportunities, and regional strategic plans.

3. In order to receive state or federal funds under subsection (4) or (6), a grant recipient shall allow access for the department or the department's designee to audit all records related to the program for which it receives those funds. The grant recipient shall reimburse the state for all disallowances found in the audit. (Section 99s (8))

4. In order to receive state funds under subsection (4) or (6), a grant recipient shall provide at least a 10% local match from local public or private resources for the funds received under this subsection. (Section 99s (9))

5. Not later than July 1, 2019 and July 1 of each year thereafter, a MiSTEM network region that receives funds under subsection (6) shall report to the executive director of the MiSTEM network in a form and manner prescribed by the executive director on performance measures developed by the MiSTEM network regions and approved by the executive director. The performance measures shall be designed to ensure that the activities of the MiSTEM network are improving student academic outcomes. (Section 99s (10))

6. Not more than 5% of a MiSTEM network region grant under subsection (6) may be retained by a fiscal agent for serving as the fiscal agent of a MiSTEM network region. (Section 99s (11))

Appendix C

MiSTEM Network Region Allocations

Proposed Fiscal Agent	Counties Included in Region	Allocation for 17-18
Alpena-Montmorency-Alcona Educational Service District	Alcona, Alpena, Montmorency, Iosco, Crawford, Oscoda, Ogemaw Roscommon, Cheboygan, Otsego, Presque Isle	$79,786
Copper Country ISD	Baraga, Houghton, Gogebic, Keweenaw and Ontonagon	$30,201
Eastern Upper Peninsula Intermediate School District	Chippewa, Luce, Mackinac	$30,201
Genesee ISD	Genesee, Lapeer, St. Clair	$110,737
Grand Valley State University	Kent, Ottawa, Montcalm, Newaygo, Muskegon, Allegan	$110,022
Huron ISD	Huron, Tuscola, Sanilac	$65,615
Kalamazoo Regional Educational Service Agency	Barry, Berrien, Branch, Calhoun, Cass, Kalamazoo, St. Joseph, Van Buren	$160,236
Macomb ISD	Macomb	$58,077
Northern Michigan University	Alger, Delta, Dickinson, Iron, Marquette, Menominee, and Schoolcraft	$90,603
Oakland Schools	Oakland	$50,336
Saginaw Valley State University	Arenac, Bay, Clare, Gladwin, Gratiot, Isabella, Midland, Saginaw	$75,323
Shiawassee Regional Education Service District	Clinton, Eaton, Ingham, Ionia, and Shiawassee	$50,336
Traverse Bay Area ISD	Emmet, Charlevoix, Antrim, Benzie, Kalkaska, Grand Traverse, Leelanau	$61,152
Washtenaw ISD	Jackson, Hillsdale, Lenawee, Livingston, Monroe, Washtenaw	$120,804
Wayne RESA	Wayne	$90,604
West Shore ESD	Mason, Lake, Oceana, Mecosta, Osceola, Manistee, Wexford, Missaukee	$90,603
Total Grant Funds		**$1,274,636**

STEM

is an acronym for the fields of study and careers in the disciplines of science, technology, engineering, and mathematics, and may include the integration of any and all of the disciplines.

Science Technology Engineering Mathematics

STEM LITERACY

STEM Literacy is the ability to identify and apply concepts from science, technology, engineering, and / or mathematics to understand complex problems and to innovate to solve them.

Students are STEM literate if they are able to apply their understanding of how the world works within and across the four interrelated STEM disciplines to improve social, economic, and environmental conditions.

STEM EDUCATION

STEM Education is a series of courses, programs, activities and/or experiences that contribute to STEM literacy, including literacy in individual STEM disciplines.

Integrated STEM is a course, program, activity, or experience within STEM education that combines concepts and applications from multiple STEM disciplines.

STEM SCHOOLS

A **STEM School** prepares students to be leaders in global innovation by engaging them in rigorous, relevant, and integrated learning experiences, with a science, technology, engineering, and mathematics focus and specialization that includes authentic research school-wide.

STEM CAREERS

STEM Careers are careers in which concepts from science, technology, engineering, and / or mathematics are applied to solve complex problems.

STEM Literacy adapted from Washington State Legislation RCW 28A.188.010
STEM Schools is adopted language from the US Senate as suggested by NCSSS

Note: *STEM definitions currently vary across the nation. The Michigan Math and Science Center Network is making strides to develop a common understanding of STEM for educators, legislators, community members, and families.*

MICHIGAN MATH & SCIENCE CENTERS NETWORK

Appendix E

MiSTEM Network Visualization Report

Sarah Galey, PhD

Abstract/Summary

This report provides network visualizations and descriptive analysis of four key professional networks in Michigan's MiSTEM system. These visualizations represent MiSTEM's network of leaders and collaborators. Individual network diagrams reveal some groups have actors that participate in most network activities, while other groups have actors that participate in different activities. The full network diagrams, meanwhile, show that the General Education Leadership Network (GELN) group is disconnected from the rest of the groups and that wide variations exist in terms of network participation between different MiSTEM regions.

Introduction

Educational researchers have documented the importance of social capital in propelling school improvement and instructional reform (Bryk & Schneider, 2002; Frank, Zhao, & Borman, 2004; Coburn & Russell, 2008; Coburn, Mata & Choi, 2010). Social relations can provide educators with access to a wide range of resources, such as trust (Bryk & Schneider, 2002), expertise (Daly & Finnegan, 2012, Frank et al., 2004; Spillane, 2004), information about local "know how" and organizational norms (Frank & Penuel, 2015), access to collaboration and sense making around instruction (Coburn, 2001), and knowledge about new instructional policies (Penuel et al., 2012). Meanwhile, the structure of social relations, or the "social network," is defined by the social interactions, or "ties," between network actors, which both constrain and enable social capital flows between network actors. In this sense, social capital can be thought of as "the resources embedded in social relations and social structure which may be mobilized when an actor wishes to increase the likelihood of success in purposive action" (Lin, 2001, p. 24). Thus, the success of policy reforms is, in part, dependent on the system's social relations through which the reform-related resources of individuals and groups may be accessed. In general, more connectedness across groups through social networks provides educators with access to a wider pool of knowledge and resources.

Network visualizations are visual representations of a system's social network and can be used to identify central actors, cohesive subgroups within the network, and opportunities to improve connectedness across the network. The visualizations presented in this brief report represent a network of MiSTEM leaders who already have exposure to one another, which helps locate expertise in the network. Moving forward, these visualizations may be used to identify areas where networks or expertise need to be cultivated to support the diffusion of expertise and to sustain constructive interaction.

Appendix E

Network Diagrams

Individual Networks (Figures 1-4)

The four networks of interest - the GELN, Michigan Science Professional Learning Network (MISciPLN), Michigan Mathematics and Science Centers Network (MMSCN), and Michigan Mathematics Consultants and Coordinators (M2C2) networks - are presented individually. Across all the networks, actors are represented as red circles and are sized based on how much they participated in the network; the more an actor participates, the larger the circle. Figure 1 shows the GELN group. Actors are red, while the events they attend are blue. This network is centered around a number of core GELN events, which most of the actors attend. In other words, the GELN group is fairly cohesive and it's likely that the majority of GELN actors have interacted with a majority of other GELN actors. Figure 2 shows the MISciPLN group. Actors are red, while the events they attend are green. In addition, there are two types of events in the MISciPLN group - regular events, which are green and Open Dialogue events, which are light green. This network is more sparse than the GELN group and different groups of actors participate in regular MISciPLN events than those that participate in Open Dialogue events. At the same time, a number of actors, which are located in the middle of the diagram, participate in both. Figure 3 shows the MMSCN group. Actors are red, while the events they attend are purple. Like the MISciPLN group, there are two types of events in the MMSCN group - regular events, which are purple and Executive Committee events, which are light purple. Most of the actors that attend Executive Committee events also frequent regular MMSCN events. These actors can be identified in the network as those actors spanning between the two types of events in the middle of the diagram. These actors are network leaders in the MMSCN group that facilitate MMSCN activities during regular events and plan during Executive Committee events. Finally, Figure 4 shows the M2C2 group. Actors are red, while the events they attend are yellow. Due to the small number of events (n=2), this network is relatively sparse. Roughly half of the actors participated in both events, while the other half only participated in one event.

Full System Networks (Figures 5-6)

Figure 5 shows the full educator network, which combines the GELN, MISciPLN, MMSCN, and M2C2 networks. The symbols used highlight how actors are connected across these groups – GELN events are blue, MISciPLN events are green, MMSCN events are purple, and M2C2 events are yellow. The large majority of the actors in the diagram are local actors with ISD affiliations (85%) and are represented by red circles. The remaining actors, which are represented by red circles-in-boxes, are network coordinators and MiSTEM resource providers (e.g., MDE staff, university researchers, etc.). In addition, the size of the symbols shows how active actors are in the network - the larger the symbol, the more that actor participates in network activities. Overall, the structure of this network highlights important actors in the network, as well as how the four groups are connected to each other. First, this diagram shows that network coordinators and resource providers are central to the network, as well as some ISD actors. These actors can be identified by their larger size and their location in the center of the network. Second, the network structure reveals that some parts of the network are relatively isolated. Notably, the GELN group, which is blue and appears on the right-hand side of the network, is separated from the other groups. In network terms, actors in the GELN group appear to have limited communications with other groups. The M2C2 group (yellow) has more connections with the other groups and is most closely

connected to the MMSCN group. Meanwhile, the MMSCN and MISciPLN groups have many overlapping actors. The MMSCN groups has more local, ISD actors, while the MISciPLN network has a high concentration of network coordinators and resource providers.

Figure 6 also shows the full MiSTEM Network, while the symbols highlight the distribution of actors from different MiSTEM regions across the state. The events in this network are labeled to distinguish between the four different groups. The actors' symbols are sized to show how actively they participate in the network. The structure of this network shows which MiSTEM regions are more prominently featured both within and across the GELN, MISciPLN, MMSCN, and M2C2 groups. Each MiSTEM region is represented by a different symbol, while the number of each MiSTEM region also appears beside the symbols. There are sixteen MiSTEM regions total. The circles-in-boxes symbols, meanwhile, show resource providers (blue grey) and MDE staff (orange) that support the network. Region 1, which is represented by pink circles, appears to be the most active network participant. Region 1 actors participate in all four groups and many of those actors participate in multiple events. Moreover, Region 1 actors do bridge between the M2C2 group and the MMSCN group. Interestingly, however, there are many actors from Region 1 in both the M2C2 group and the GELN group that do not interact with the MMSCN or MISciPLN groups. Next, Region 6 (olive diamond) and Region 8 (purple down triangle) also appear frequently across the network. Both Regions 6 and 8 have multiple ISD actors in each group and have central actors that participate in multiple groups. Next, Region 3 (orange triangle), Region 4 (turquoise box), and Region 5 (green down triangle), Region 9 (turquoise double triangle), and Region 10 (grey square) have ISD actors in each group with a few central actors that participate in many events - although a few less than Regions 1, 6, and 8. Region 2 (grey blue square), meanwhile, also has many actors across the network, but actors from this region participate in fewer events than the other regions. The remaining regions - Region 7 (dark blue diamond), Region 11 (brown circle), Region 12 (red circle), Region 13 (dark red circle), Region 14 (brown triangle), Region 15 (blue box), and Region 16 (pink down triangle) - have less network participants than the other groups, although they do participate in most of the groups. Overall, this network structure is an indicator of opportunities to interact and does not necessarily mean relationships have been formed or are being utilized. At the same time, the large majority of actors in the GELN group have actors from the same region in other groups. Thus, it is possible that actors from GELN are interacting with actors from the other groups back in their home regions. Likewise, having many actors present in the network may not be a guarantee that regions are active participants, but could instead be a reflection of more resources and higher staffing levels. Rather, these diagrams provide a baseline for examining the impact of MiSTEM professional networks on educator development, knowledge sharing, and capacity-building for improving STEM outcomes across the state. We know, for example, that actors participating in multiple events together are much more likely to forge professional relationships with actors they see frequently. Moving forward, participants would need to be surveyed or interviewed to better understand the implications of the network structure.

Appendix E

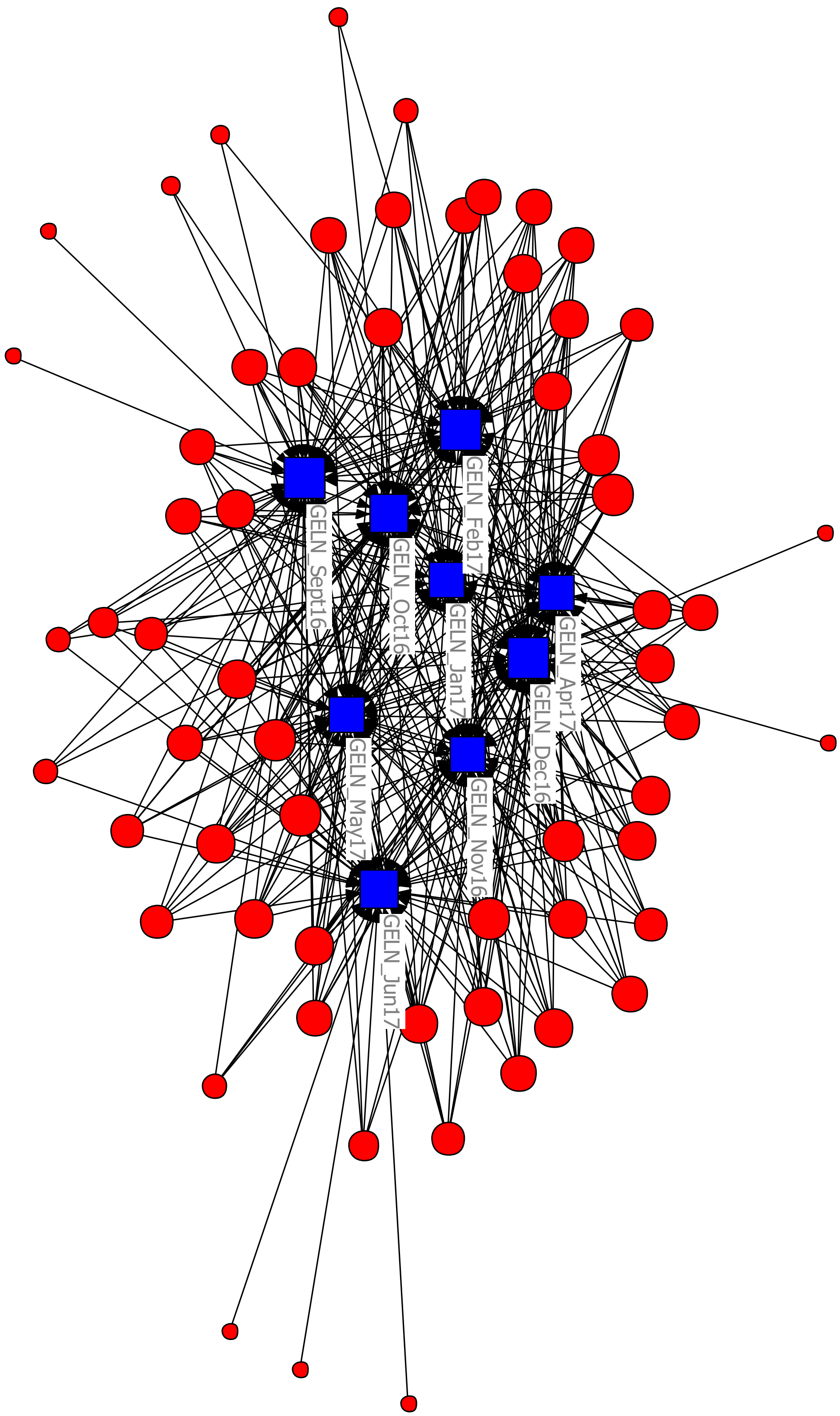


Fig 1. GELN Network.
KEY – Circles: Red = Actors; Squares: Blue = GELN Events

Fig 2. MISciPLN Network.

KEY – Circles: Red = Actors; Squares: Dark Green = MISciPLN Events; Light Green = MISciPLN Open Dialogue Events

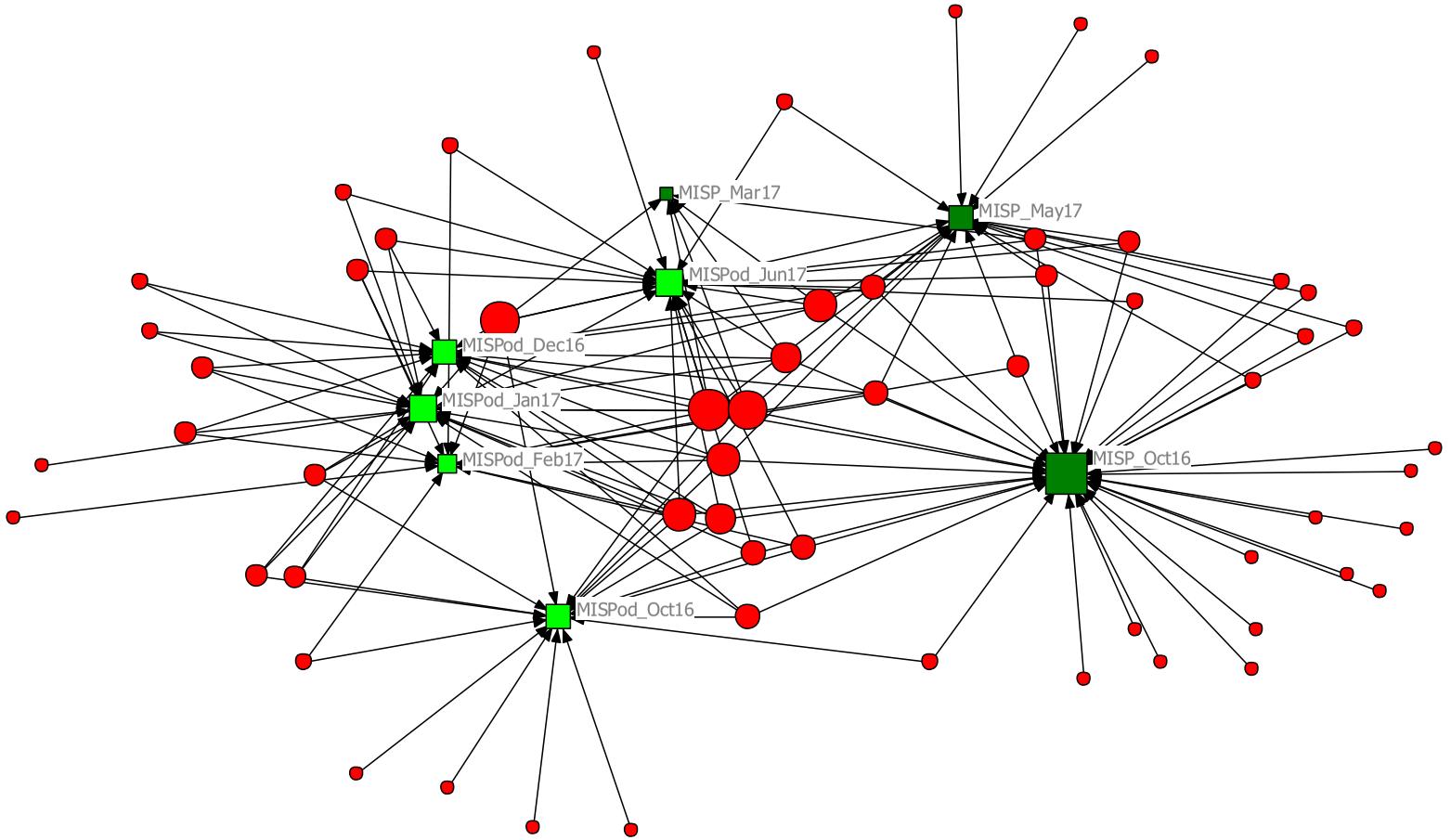
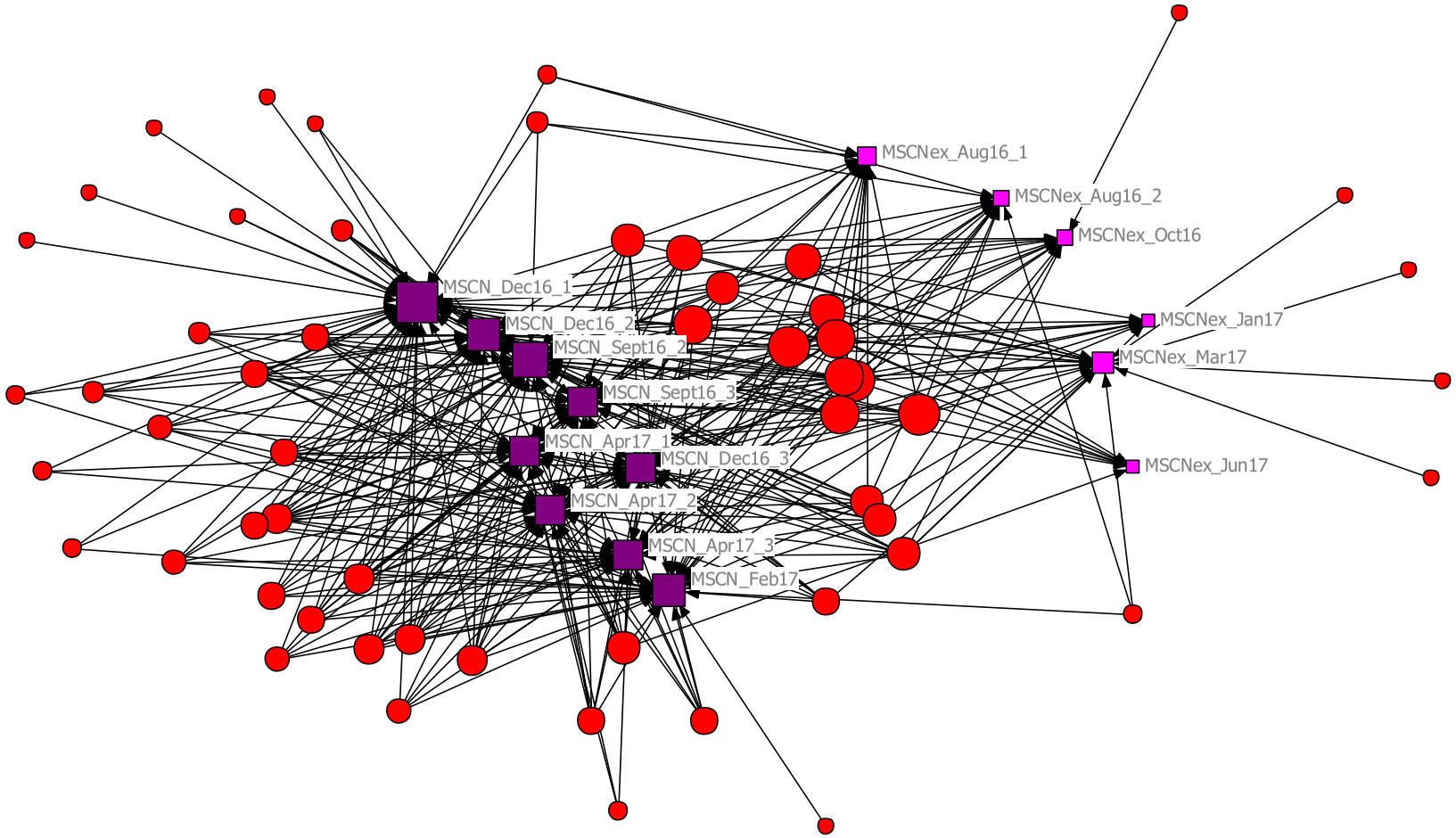


Fig 3. MMSCN Network.

KEY – Circles: Red = Actors; Squares: Dark Purple = MMSCN Events; Light Purple = MMSCN Executive Committee Events



Appendix E

Appendix E

Fig 4. M2C2 Network.
KEY – Circles: Red = Actors; Squares: Yellow = M2C2 Events

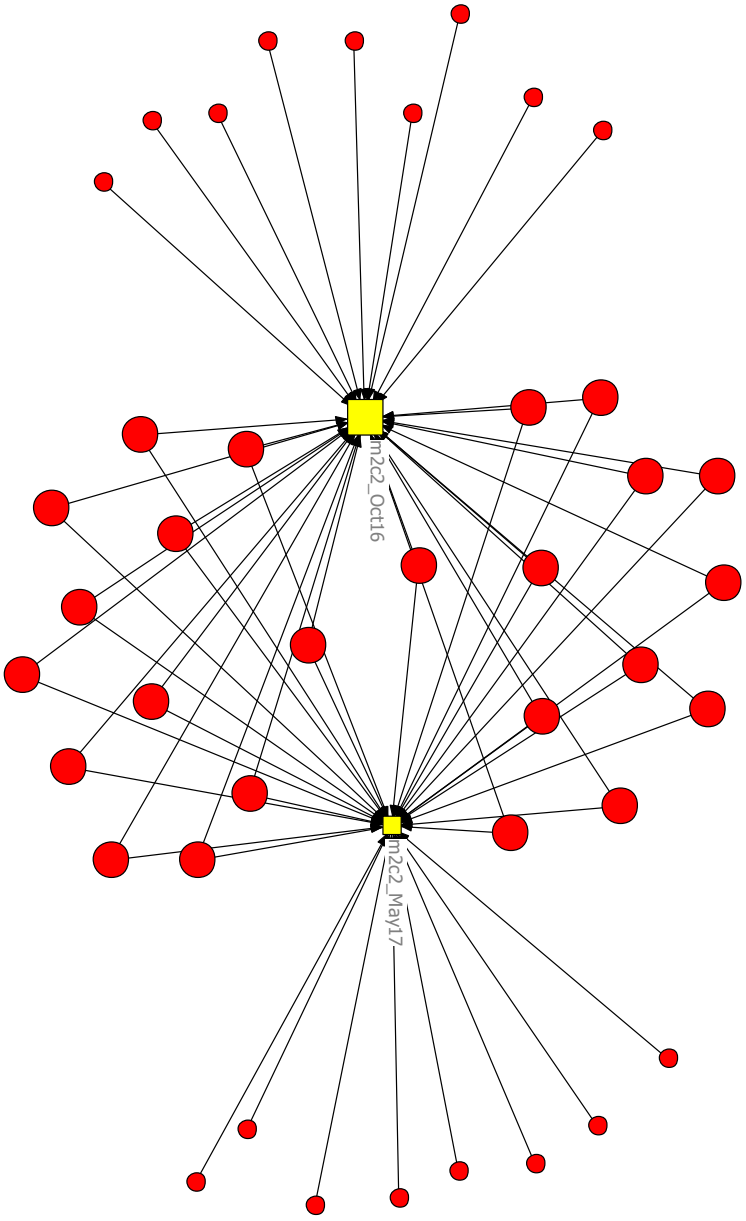
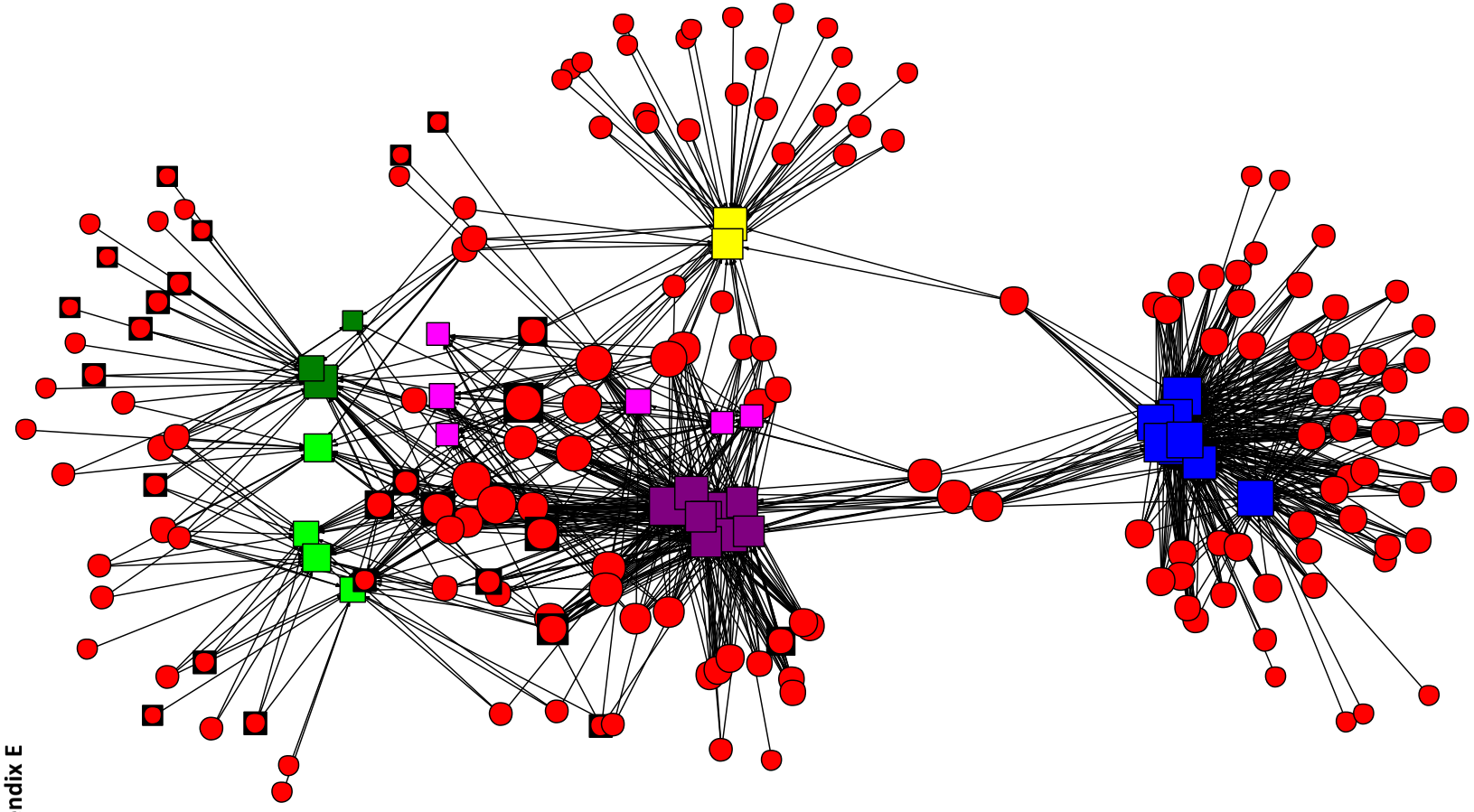


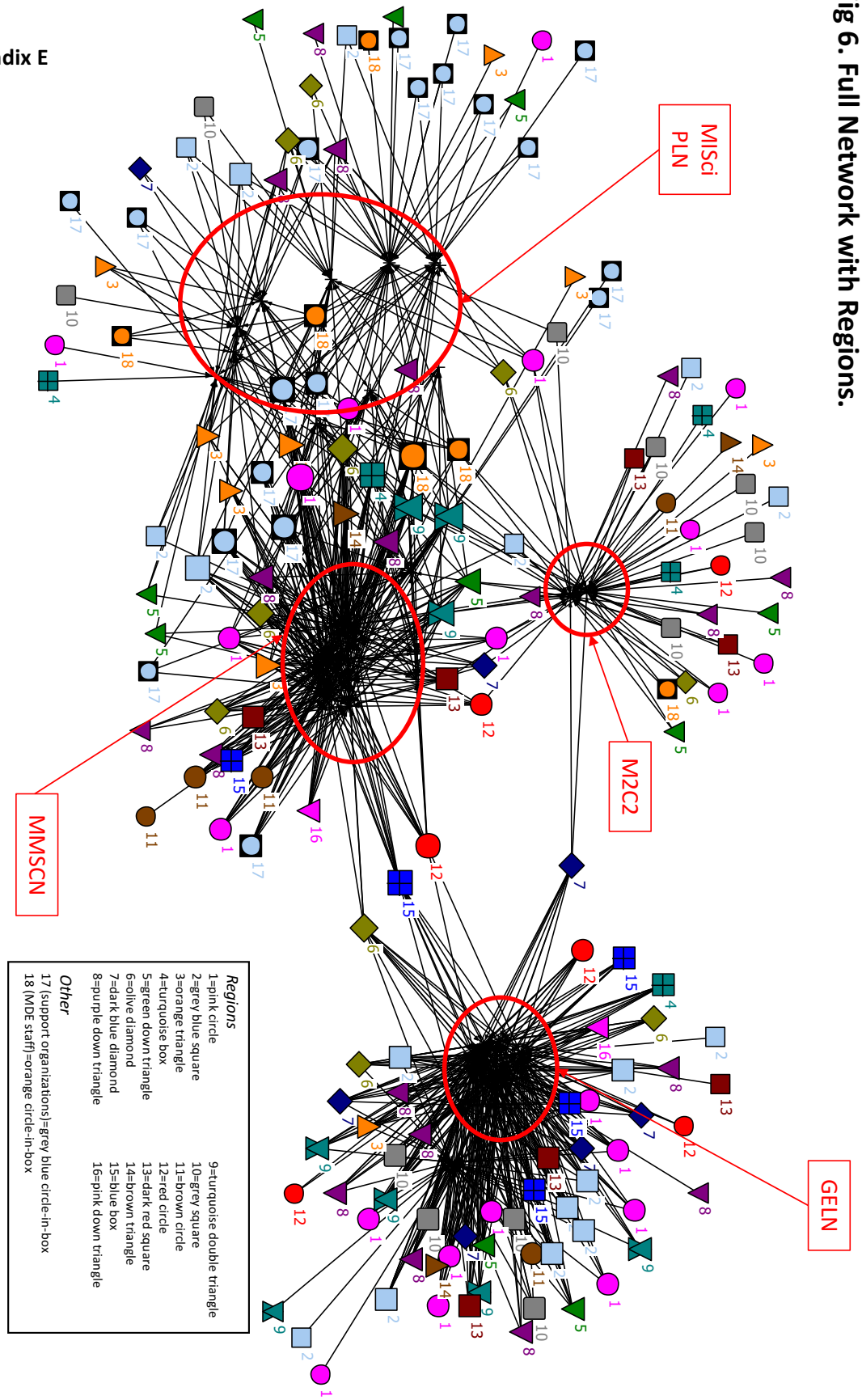
Fig 5. Full Network.

KEY – Circles: Red = Educators; Circle-in-Box: Red = MDE/Resource Providers; Squares: Blue = GELN Events; Dark Purple = MMSCN Events; Light Purple = MMSCN Executive Committee Events; Dark Green = MISciPLN Events; Light Green = MISciPLN Open Dialogue Events; Yellow = M2C2 Events



Appendix E

Fig 6. Full Network with Regions.



Appendix E

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Appendix F

Programmatic Staffing Calculations

Staffing levels were calculated for the professional learning provider role (PLP) and instructional coach role (IC) based on student count data collected from the MiSTEM GIS portal which draws from the Educational Entity Master. In the master STEM educator ecosystem, collaborators can wear multiple hats for purposes that are distinct. For the staffing calculations below, it was necessary to place some constraints in order to calculate a number. In these calculations, the PLP and IC are considered to be separate individuals that have no other duties assigned. The implementation timeline was considered to be one year for each of the roles to complete their duties at an adequate level, which is defined by Banilower et al. (2006) in their report to the National Science Foundation on teacher enhancement initiatives. This research shows that the greatest impact on learning comes when 80 hours is spent in professional learning (PL). In our calculations, the professional learning total was split between time spent in large groups with the PLP and in one-on-one settings with an IC. An important point to keep in mind is that the IC needs to attend the same PL that their coachees (the teachers) are attending--either as the PLP or as a participant. After the PL, the IC role takes over to make sure the practices/instructional skills from the PL are mastered. PL and IC do not run simultaneously, but rather consecutively. It is also important to acknowledge that for ICs to be effective in helping teachers to become masterful in a new practice, the literature suggests that three to five years will be needed (Fullan, 2010; Fullan, 2011). This is true for each new initiative, which means that staffing levels and the potential number of new initiatives that can be undertaken are closely tied to one another.

No staffing recommendation is made for the other leadership capacities represented in the master STEM educator ecosystem because those positions would not usually be hired as staff in a region, but would most likely come from the collaborators that work across the entire state. Therefore, these calculations help us to project the personnel that would be needed to scale the entire state in one year in one particular program K to 12. With that caveat in mind, the number of PLP in Table 2 was calculated as follows:

1. The MiSTEM GIS portal was used to find the total number of K-12 teachers in each region
2. It was assumed that student to teacher ratios of 30:1 are the typical caseloads allowed in teacher contracts
3. The total number of PLP needed was then estimated by:
    a. multiplying the number of teachers per region by 40 hours of PL per year per teacher
    b. dividing by 15 teachers served per PL day
    c. dividing by 6 hours per PL day
    d. dividing by 90, the total number of contracted PLP days per provider

    The number of 40 hours for PL is based on the research from a report to the National Science Foundation from Horizon Research Inc. (Banilower et al. Dec 2006). This research shows that the greatest impact on learning comes when 80 hours was spent in PL. As mentioned above, 40 hours was used for PL and 40 hours was then used for IC. The choice for the 15:1 teacher to PLP ratio is based on work from the Next Generation Science Exemplar project researchers. This project has tried to quantify the reasonable caseload that a PLP can handle on their own for a multi-hour, multi-day PL experience. The number of contracted PLP days of 90 was determined by gathering information from current math and science PLP. On average the PLP in our state are assigned a 185-day contract which resembles the school year calendar, even though in some regions the PL may largely be provided during the summer months. The PLP then estimated the preparation time necessary for each session that they would be providing similar to the planning

time that a classroom teacher would receive in their contract. There is also time built in to those contract days for PLP to attend their own PL to make sure that they have the capacity to deliver the program and reflect on their practice to improve. These days were not counted as days that they would be providing the PL. While these types of practices are fairly well defined for the classroom educator, they are not formally defined for the educator that works with the classroom educators. Therefore, various resources and research was sought out to estimate this calculation.

Based on information gathered from the field, on average it takes 1-3 days of preparation for every one day of PL provided depending on the program and how many times the program has been delivered. For a minimum 6-day session (based on 40 hours of PL and approximately 6-hour-long PL days) this would allow for 15 cycles of the PL program in 90 days and at least 90 days of preparation time. This only leaves 5 days of wiggle room in a contracted year. Therefore, this is a fairly ambitious calculation, but not impossible.

As was mentioned previously, knowing what it takes to provide the professional learning space for the PLP is a critical point missing from the research literature. The ecosystem structure could serve to address this gap and allows us a monitoring mechanism going forward to evaluate if our estimates for staffing are appropriate. The ecosystem structure and the formula to calculate staffing also allow for variables to be adjusted based on the program needs to assign different staffing models.

Staffing levels for IC were calculated similarly:

1. It was assumed that student to teacher ratios of 30:1 are the typical caseloads allowed in teacher contracts
2. The total number of IC needed was then estimated by:
    a. multiplying the number of teachers per region by 40 hours of PL per year per teacher
    b. dividing by 4 teachers served per instructional coaching day
    c. dividing by 6 hours per instructional coaching day
    d. dividing by 80 which was calculated from the total number of coaching days per provider per year

80 days to provide IC out of a typical contracted 185 day schedule accounts for the amount of time that an IC will need to spend completing their own PL, planning, scheduling, preparing for the coaching sessions, and reflecting upon their own work after the coaching sessions. Based on data collected from the field, it is a goal to provide at least 2 coaching sessions for every one day of PL. Each coaching session is approximately 3-4 hours long. It also takes approximately the same amount of time to plan and prepare for the coaching sessions as it does to implement them. Therefore, for a minimum of 40 hours of PL provided through IC, this would allow for a targeted 10 cycles of IC per teacher per year. If there are 80 days of IC and 80 days of preparation, that leaves 25 days a contracted year for the IC to attend to their own professional preparation and reflection time. Again, this is an ambitious schedule, but it is possible and reflects the goals set by current coaching structures in our state.

Appendix G

Glossary of Acronyms

Advisory Council	Governor's MiSTEM Advisory Council
CEPI	Center for Educational Performance and Information
ESSA	Every Student Succeeds Act
GELN	General Education Leadership Network
GTIB	Governor's Talent Investment Board
IC	Instructional Coach
ISD	Intermediate School District
LMISI	The Michigan Bureau of Labor Market Information and Strategic Initiatives
MDE	Michigan Department of Education
MEDC	Michigan Economic Development Corporation
MiSTEM	Michigan STEM
MMSCN	Michigan Math and Science Centers Network
PL	Professional Learning
PLP	Professional Learning Provider
pED	Permanent Executive Director
tED	Transitional Executive Director