Taking Stock of Oregon STEM Hubs:

Accomplishments and Challenges

An Evaluation Report Prepared for the Oregon Chief Education Office

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Executive Summary

Introduction. The Center for Research on Lifelong STEM Learning at Oregon State University (OSU) collaborated with the Educational Policy Improvement Center (EPIC) on a yearlong capacity-building research project in order to better understand the common and unique features and strengths of Oregon's STEM Hubs. OSU's goal of the project was to examine the growth and success of the STEM Hubs and their partners to lay the foundation for co-developing tools that assess the effectiveness of the Hub partnerships as collective action. The project is the first of its kind to systematically examine multiple layers of collaboration between publicly funded STEM-focused organizations, partner organizations, and their broader communities.

STEM Hubs are regionally-focused, multi-sector partnerships that unite schools, universities, non-profits, businesses, civic leaders and other members of communities in so-called local STEM (Science, Technology, Engineering, and Mathematics) learning ecosystems. STEM Hubs as organized local learning ecosystems have their origin in recent research on effective STEM programming which strongly recommends integrated approaches to teaching and learning that include not only all students, but also all assets for learning, and that build on the simple truth that learning does not only occur within classrooms. The purpose of creating these organized local STEM learning ecosystems called STEM Hubs, therefore, is to drive STEM innovation and evidence-based practices in teaching and learning at the systems level. Designing and curating connected learning across time and space by making use of local STEM assets, involvement of all community partners in a local learning ecosystem, a focus on quality of life and economic opportunity and the development of social (science) capital are underlying mechanisms that allow STEM Hubs to create short- and long-term impacts. STEM Hubs are implementing strategies that include (amongst others) educator professional development on best practices in STEM instruction; in- and out-of-school, hands-on STEM learning experiences for students; and connections to fast-growing STEM employment opportunities in Oregon. But most importantly, STEM Hubs are creating connectioons between programs, thereby ensuring that they develop their full effectiveness.

Purpose. The main research goal for this study was to describe how investment into the Hubs has influenced local STEM communities; that is, how STEM Hubs have begun to create opportunities for partnerships, collaboration, connected programing, improved program development or delivery, or improved communication within and outside the STEM teaching and learning community. Based on these findings, the report provides recommendations for improvements and future investments. Ultimately, the study is aiming at establishing whether and to what degree STEM Hubs are helping to improve opportunities for effective teaching and learning for all Oregon children.

Scope of final report. This report draws from survey and interview data to provide insights into the STEM Hubs' "ecosystem" of local or regional integrated STEM teaching and learning within and across each STEM Hub. The findings inform recommendations for investments into future capacity building for improved STEM and CTE learning opportunities.

Methods. Data were collected from STEM Hub backbone staff and STEM Hub partners using an online survey designed to assess features of collaboration and the health and vibrancy of the local STEM Hub community. A select group of STEM Hub partners were also interviewed in order to better understand the unique features and context of each partnership.

Results. Data indicate that investments into backbone structures and programming by the state have been instrumental in creating local STEM Hubs as communities of practice focused on providing rich STEM learning opportunities for all. Across STEM Hubs, partners and backbone staff are reporting positive change as a direct result of Hub activity, even those from the second cohort, which was only recently funded. Additionally, STEM Hubs are reporting a wide variety of ideas for promoting further success of their respective STEM Hubs. Overall, backbone staff and partners report satisfaction with the structure and functioning of their regional Hub, with most concerns mainly focused on sustained funding and sufficient staffing.

Key Findings in Detail

- The design of STEM Hubs is tied to **multiple conceptual frameworks** that are themselves based on established theory for learning and for creating social change. We therefore find that the design principles of STEM Hubs can be considered research-based.

- Partners and backbone staff across all STEM Hubs agree that **K–12 STEM education** is a main focus of their work. How they approach this main goal differs somewhat among the Hubs and represents local or regional priorities.

- Hubs differ in regard to their focus on **Career and Technical Education (CTE)**, which is the focus of some but not as strongly developed in others. The same is true for early learning, which tends to be less of a focus for most Hubs (or may not be as strongly identified as a focus by partners). Since Hubs overlap in some communities with Early Learning Hubs or Regional Achievement Collaboratives, early learning initiatives or CTE education might be addressed by those other entities.

- Other areas of focus for STEM Hubs included preparing students for STEM careers and providing teacher/educator professional development. It can and should be an opportunity for discussion for some Hubs to clarify and communicate about the main foci of their Hub as data showed some lack of agreement (or lack of awareness) of the main foci of the Hub.

- Partners and backbone staff of STEM Hubs are reporting **positive change** as a direct result of the Hubs, even those from the second cohort, which was only recently funded. Direct benefits included more and improved STEM programming for children, support for

teachers and other educators, improved coordination and cooperation between local partners, or better communication between partners and between STEM education stakeholders and the wider communities of the Hubs.

- Direct positive change in new Hubs is mostly reported in the area of **communication**, indicating that the process of forming Hubs itself played an important role in community building.

- STEM Hubs are reporting a wide variety of ideas for promoting further success of their respective STEM Hubs. Although **sustained funding** and **sufficient staffing** together were mentioned the most, other aspects such as improved external communication and outreach to better embed the Hub into its community, strategic planning to further focus the Hub, improvements to the partnership arrangement, or developing more programs were also mentioned, as was that Hubs were working fine and did not need any improvement at all. There are no silver bullets for strengthening Hubs at this time, but there are many ideas that emerged from the surveys and interviews that Hub leaders can make use of in their process of continuous improvement.

- Overall, STEM Hub members are reporting **positive connections** within and across STEM Hubs, indicating that the communities of the STEM Hubs are developing. Overall, partners and (more so) backbone staff report that they can make positive contributions to the Hubs, and that they developed trusted relationships between partners and between partners and the Hub's leadership. Measures of the Hub's "health" (i.e., the degree to which individuals have voice within the Hub and trust other members of the Hub) score high. However, data also indicate the need in some Hubs to ensure that all partners be fully included in the Hub's community.

- Initial evidence exists that at least some more established and adjacent STEM Hubs are making connections between each other, and between STEM Hubs, Early Learning Hubs and Regional Achievement Collaboratives. Connections among STEM Hubs and between Hubs and other networks are ultimately needed to ensure some form of "diffusion of innovation" in Oregon, and to create a **statewide community** that can be leveraged for improving STEM education and can act as a voice for education in the public sphere. Many STEM Hubs expressed interest in further developing their connections among these networks, but stated a need for the State to facilitate this with greater support.

- Many STEM Hub activities and collaborations in and between schools, community organizations, and business and industry would not have been possible without **leadership and resources from the local STEM Hub.**

- STEM Hubs were excited to engage with OSU and EPIC in sense-making sessions where we reviewed data from their STEM Hubs with them. Many of the STEM Hubs expressed interest in continuing this type of data collection in order to get **regular feedback** that can

help them **improve and monitor** their progress, and all expressed interest in connecting with other STEM Hubs on a regular basis to get and exchange ideas for strengthening their own Hub.

Oregon STEM Hubs: An Introduction

The Chief Education Office, in collaboration with the Oregon Department of Education (ODE), directly or through partner education agencies, has funded several collaborative partnership programs focused on improving key education outcomes throughout Oregon. These collaborative partnerships include the Early Learning Hubs, Regional Achievement Collaboratives (RACs), and a statewide network of Regional STEM (Science, Technology, Engineering, and Mathematics) Hubs. Each collaborative is focused on coordinating regional communication and partnerships, improving key student outcomes, building capacity and sustainability for change, and encouraging and supporting local and statewide multisector engagement.

In 2013, the Oregon Legislature passed House Bill 3232, Strategic Investments: Connecting to the World of Work, as a means to provide significant funding to strengthen and expand Oregon's focus on the importance of developing strong programs in science, technology, engineering arts/design, and mathematics (STEM/STEAM). Connecting Oregon students to the world of work by expanding STEM and career and technical education (CTE) programs aligns Oregon with the national priority of keeping our students competitive and preparing them for leadership roles within an increasingly globalized and technical workplace. There is an increasing demand for workers with the content knowledge and skills required to fill fast-growing and high-paying positions within the STEM fields. Filling these positions with locally grown talent also requires that Oregon create and sustain a college-going culture in Oregon schools by supporting programs that prepare students for a successful transition to certificate programs and/or college. Additionally, providing a talent pool of individuals with the skills desired by employers in the STEM occupations will attract and retain STEM businesses and industries in Oregon, contributing to regional and statewide prosperity. Furthermore, students with a strong background in STEM education will contribute to a more scientifically literate populace that will have the critical thinking skills necessary to make balanced and thoughtful decisions that will benefit society as a whole.

In a rapidly changing, technologically rich, global society, literacy in STEM is required to participate in, and drive, an innovation-based economy. Jobs in the 21st century require individuals with the knowledge, skills, and mindsets that will enable them to adapt to flexible workforce needs and to compete for high-wage, high-demand careers. Employment projections by the U.S. Department of Labor's Bureau of Labor Statistics show that more than 80% of the fastest-growing occupations projected over the next ten years require significant mathematics or science preparation.[1] It is widely recognized that high-quality, cross-disciplinary STEM education encourages skills such as critical thinking, problem solving, collaboration, and creativity.

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[1] Jones, 2014

The statewide network of regional STEM Hubs is an economic development strategy created in order to meet two key goals set forth by the Chief Education Office's STEM Investment Council:

- Double the percentage of students in 4th and 8th grades who are proficient or advanced in mathematics and science.

- Double the number of students who earn postsecondary credentials requiring proficiency in high-wage, high-demand STEM fields.

To date, 11 STEM Hubs have received funding to establish multisector partnerships linking local educators, community members, and business/industry representatives in a collaborative move to transform the landscape of STEM teaching and learning. Figure 1 shows the geographic distribution of the STEM Hubs for the 2015–2017 biennium.

Cohort 1
o Central Oregon STEM Hub
o Greater Oregon STEM Hub
o Oregon Coast STEM Hub
o Portland Metro STEM Partnership
o South Metro-Salem STEM Partnership
o Umpqua Valley Regional STEAM Hub

Cohort 2
o Columbia Gorge STEM Hub
o East Metro STEAM Partnership
o Frontier Oregon STEM Hub
o Lane County STEM Hub
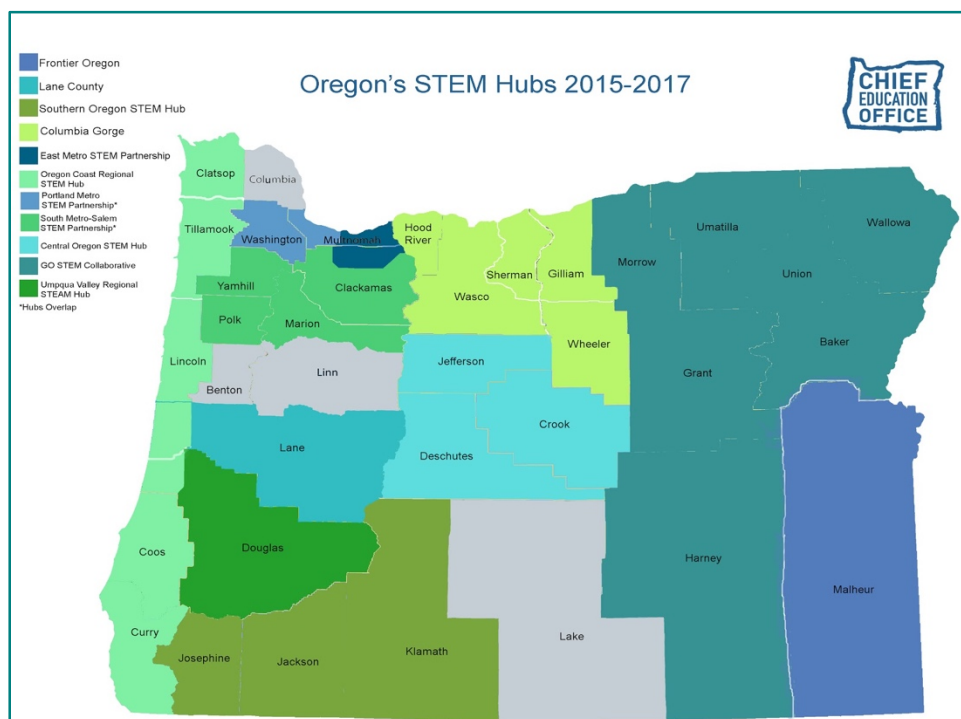o Southern Oregon STEM Hub

Figure 1. Geographic distribution of Oregon's STEM Hubs.

STEM Hubs as Ecosystems

Since their inception, STEM Hubs have each developed their own individual identities, priorities, and outcomes. Some of the collaboratives have established initiatives in their respective regions for a number of years before the recent Chief Education Office/ODE funding, with well-developed networks of partnerships and programming efforts already reaching a large number of students and educators. Others, after receiving funding, have only begun to organize themselves internally and put structures into place to support locally identified goals. Regardless of their developmental position, all the collaboratives share a commitment to improving key student outcomes in their regions through a variety of activities, including the direct deployment of programming activities for students and educators, as well as the support of programming activities already put into place by partner organizations. The collaboratives have also been seeking ways in which to elevate and expand their current work through connections with other RACs and STEM Hubs around the state, and identifying ways in which they can share resources that will increase efficiency and effectiveness.

Creating local ecosystems for STEM education constitutes a shift from an institutional focus to a learner focus. This approach to improving STEM education, which is the principle behind the creation of the STEM Hubs, is research-based and has been detailed in two recent reports by the National Academy of Sciences, Engineering and Medicine[2][3] as well as in two working papers for a consortium of private foundations and corporate funders who pursue a common goal of creating systemic positive change in STEM education nationwide.[4][5] The key idea that emerged from the research literature on how best to support learning was to build on, nurture, support, expand, and actively manage a STEM learning ecosystem for each learner. Instead of asking what individual organizations can or should do in isolation of others to support a STEM learner, the focus lies on collective impact of all organizations that support learning of individuals within their local contexts (see Figure 2).

In STEM Hubs, the principles of local STEM learning ecosystems are operationalized based on three well-established theories: that of communities of practice,[6] of professional learning networks,[7] and principles of collective impact.[8] Business and other professional communities often use connected networks for sharing best practices. A "community of practice" (CoP)[9][10] is

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[2] National Research Council, 2014

[3] National Research Council, 2015

[4] Traphagen & Traill, 2014

[5] Traill & Traphagen, 2015

[6] Wenger, 1998

[7] Bryk et al., 2011

[8] Kania & Kramer, 2011

[9] Lave & Wenger, 1991

[10] Wenger, 1998

where individuals with common goals and common professional practices form supportive communities that influence individuals via shared norms, customs, practices and various layers of communication and engagement. A very specific application of this idea can be found in so-called networked improvement communities, or NICs,[11] which have been used successfully to improve school culture. Networks enable individuals from many different contexts to participate according to their interests and expertise while sustaining collective attention on progress toward common goals. Since these communities strive toward common goals, the principles of collective impact (CI) might help accelerate progress and lead to agreement on common measures of success. Collective impact organizations are defined by five characteristics: (1) a common agenda, (2) shared outcome measurement, (3) continuous communication among partners, (4) mutually reinforcing activities, and (4) "backbone" support from committed staff.[12] STEM Hubs are encouraged to use the elements of collective impact to form and sustain networked improvement communities of practice that allow for productive participation at any level. In this way, STEM Hubs represent the designed STEM Learning Ecosystem for a community.
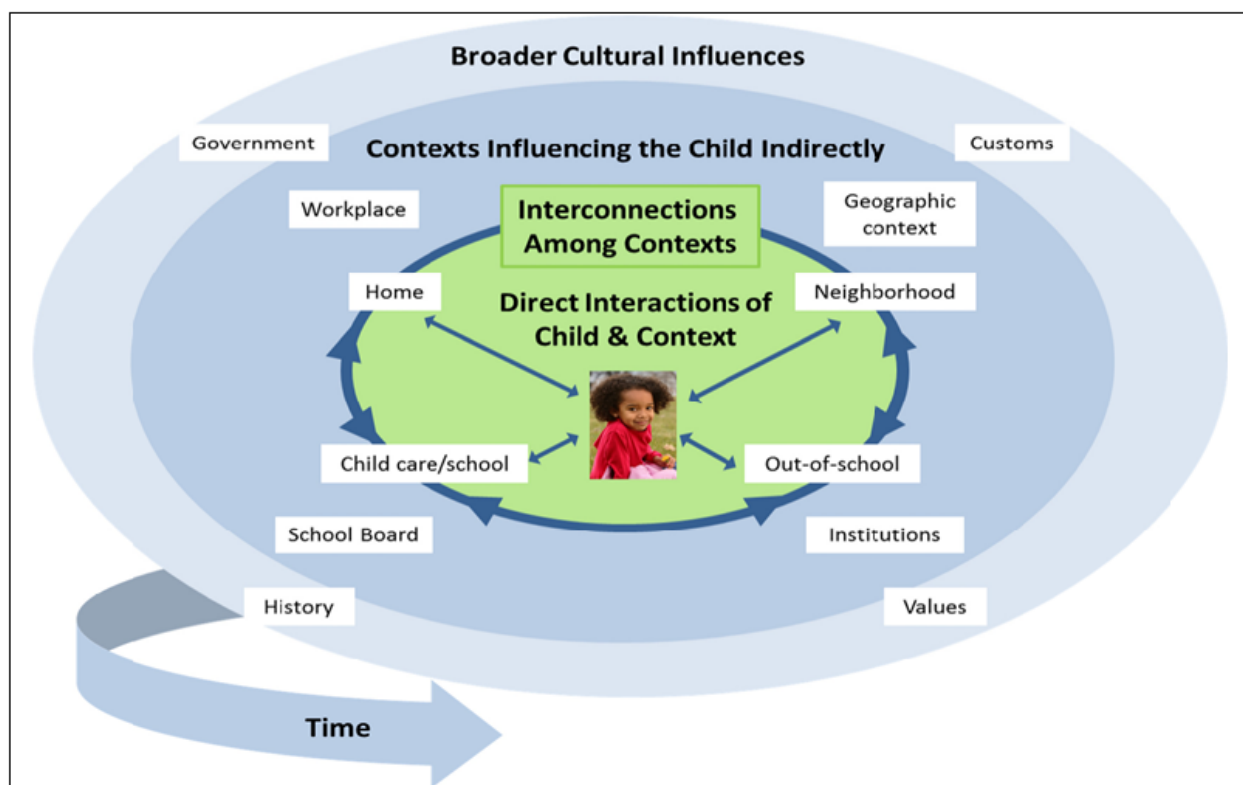

Figure 2. STEM learning ecosystem for a community.

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[11] Bryk, Gomez, & Grunow, 2011
[12] Kania & Kramer, 2011

Scope of the Final Report

The current project is the first to systematically examine multiple layers of collaboration between publicly funded STEM-focused organizations, partner organizations, and their broader communities. The ultimate goal of this effort is to provide specific, data-driven recommendations that will help to strengthen and sustain the positive, regional partnerships between the STEM Hubs and their communities as they work together to promote positive STEM outcomes across Oregon. This report is intended to provide insights into the nature of the collaboration between the Hubs and their various partner organizations. Specifically, we explore the following question:

How do STEM Hub backbone staff and STEM Hub partner organizations view the following:

a) The Hub's progress toward its goals

b) The nature and quality of the Hub's collaborative efforts

c) The perceived accomplishments of the STEM Hubs to date

d) The development of a local STEM ecosystem

e) The development of community around STEM Hubs

f) The connections that exist between STEM Hubs.

Results

Progress Toward STEM Hub Goals

Figure 3 shows that most (90% or more) STEM Hub leaders/backbone staff and their partner organizations report that the STEM Hubs are making satisfactory or exemplary progress toward their goals. Partners are more positive about progress towards goals than STEM Hub staff: 40% of partners, but 22% of staff, think that progress so far has been exemplary, and 50% of partners, but 72% of staff judged progress to be satisfactory.
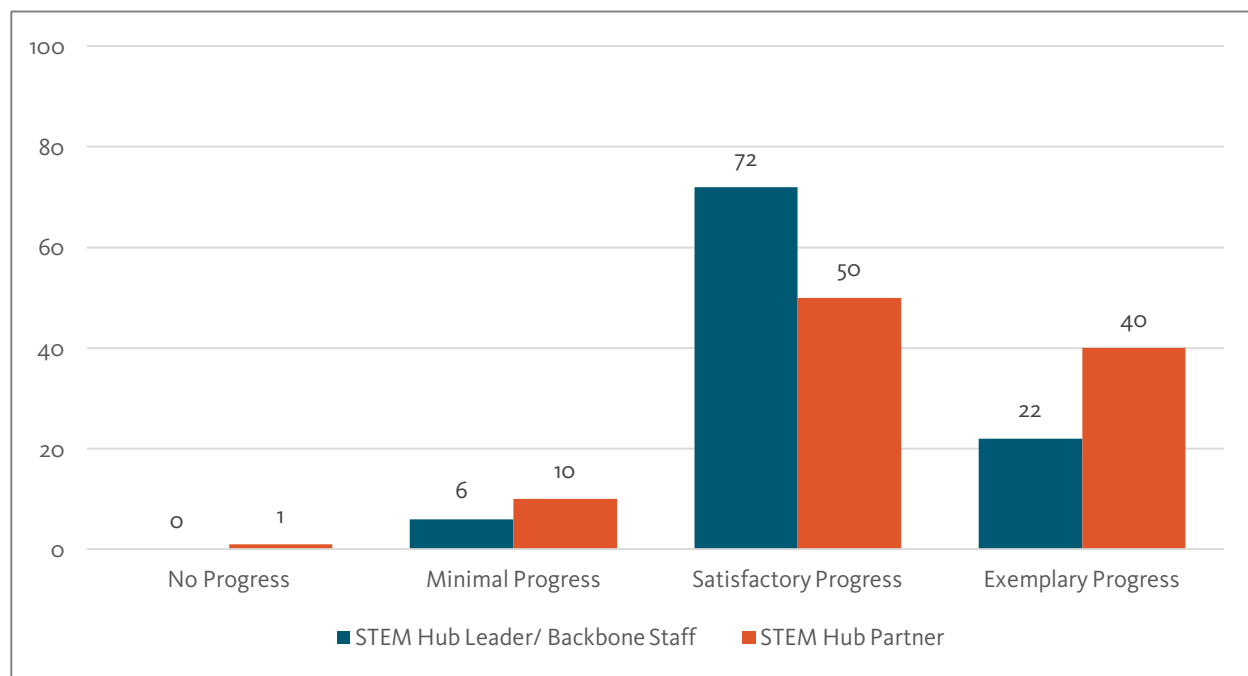

Figure 3. To what extent are STEM Hubs progressing toward their goals?

Accomplishments of the STEM Hubs

When asked what one change respondents could identify *as a result of the STEM Hub*, improved or new types of student programming was mentioned most frequently, followed by improved communication and exchange by various partners within the Hubs, new or improved professional learning opportunities for educators, access to resources that were previously not available, direct help in implementing change or programs, increased awareness of the need for and the existence of increasing efforts toward local collective action around STEM/CTE education, and a general sense of improved collaboration around STEM within the local community (see Figure 5). Important to note is that by asking respondents to provide only one example, they are giving the most important, salient or top-of-mind "value-added" of the Hub, rather than a comprehensive list. Although some respondents could not help but provide more than one answer, the nature of the question allows us to see any of the answer categories, no

matter how small the frequency of the answers within, as important. For descriptions of each of the codes, see the technical appendix.

The interviews with partners generally corroborated survey responses; interviewees gave similar types of answers about accomplishments of the STEM Hubs when asked, "what exists now that didn't exist before your STEM Hub." A partner with South-Metro Salem STEM Partnership noted that "[The Hub has been] key with getting our teachers invested in STEM. We have this group of now highly trained teacher-leaders around STEM who have really been the impetus for developing STEAM and STEM courses in and programs in every school in our district… [Now with a support bond from the community,] we are putting in maker-spaces and STEAM classrooms across the district. The impact has been pretty profound." A partner with Greater Oregon STEM Hub reported that "providing professional learning communities for teachers and community educators is a value add as a result of the STEM Hub."

> "The STEM Hub is starting to function as an ecosystem. Awareness of resources [exists] in a way that was never there before. Less duplication of efforts, stronger messaging for industry which has never found a way in the past to "play" to make opportunities available to younger students."
> –Portland Metro STEM Partnership Partner

When asked what they would say about their STEM Hub if they had the opportunity to speak with Governor Kate Brown, some interviewees chose to give specific positive examples of programming with students. One Frontier STEM Hub partner wanted to tell the governor about an event on which they just partnered with the STEM Hub. "The event was a resounding success because it allowed us to give 7th graders (across the county, more than 300 students) in Malheur County a hands-on interaction with science and technology on a college campus, plant a seed about college, and partnering with others we were able to highlight seven different jobs within the hospital and how it ties in with science. It was very innovative."

Other interviewees chose to describe the formation of a network and collective impact kinds of ideas to the Governor.
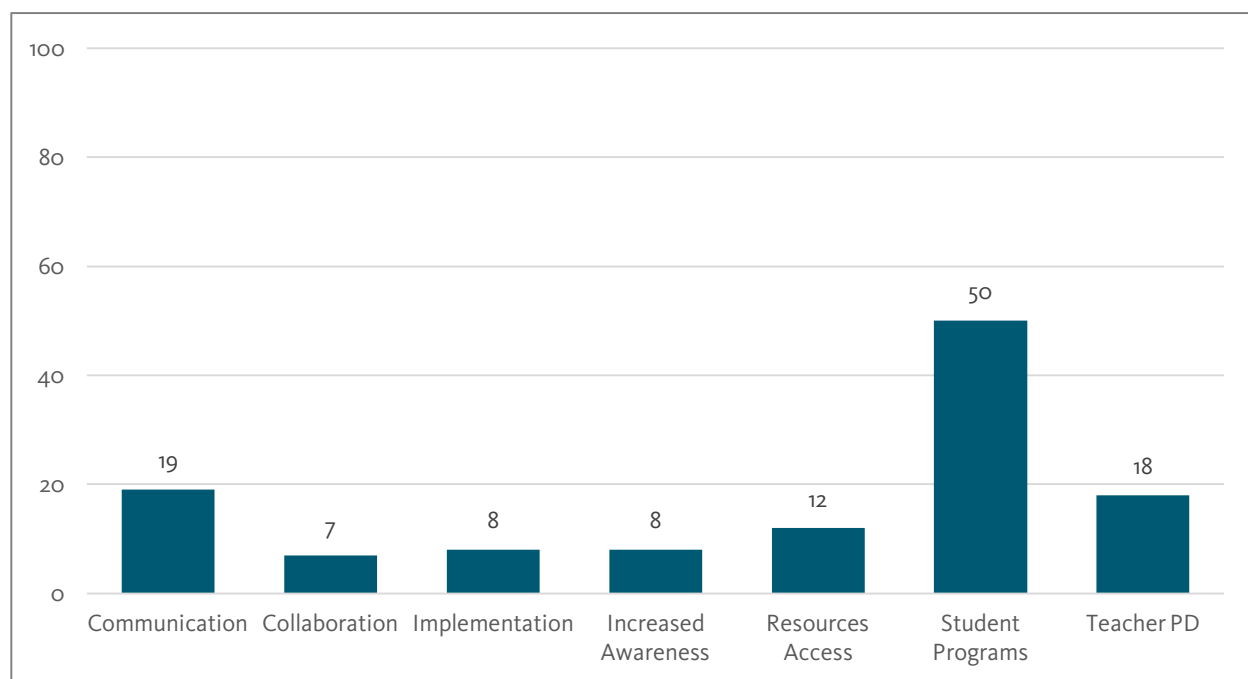
Figure 5. One positive change as a direct result of the work of the STEM Hub (% of respondents).

Asked in a similar fashion about the one thing that would make their respective STEM Hub more successful, not surprisingly almost a third of the respondents indicated sustained, increased, or more predictable funding, and relatedly, another 12% of respondents mentioned increasing staff capacity (see Figure 6). However, one in six respondents each mentioned improved external communication, outreach, or engagement to ensure that the Hub and its work is better known and understood in the community. One in 12 respondents mentioned more or better opportunities for students and educators/teachers and nearly one in five making improvements to the existing partnerships themselves.

The interviews with partners supported survey responses; interviewees gave similar types of answers about opportunities for making their STEM Hub more successful when asked, "What is something your STEM Hub really needs and doesn't have yet (or needs to expand on or improve) in order to fulfill its potential?"

An East-Metro STEM Partnership partner who have been involved with multiple STEM Hubs wanted to take a hypothetical opportunity to have coffee with the governor to tell Governor Brown that it was important to have organizations that oversee whole regions to make connections between business and schools. He was concerned about duplication between the regional coordinators for CTE and the STEM hubs. Other partners also wanted to share a general concern about CTE funding and how that would impact STEM Hubs.
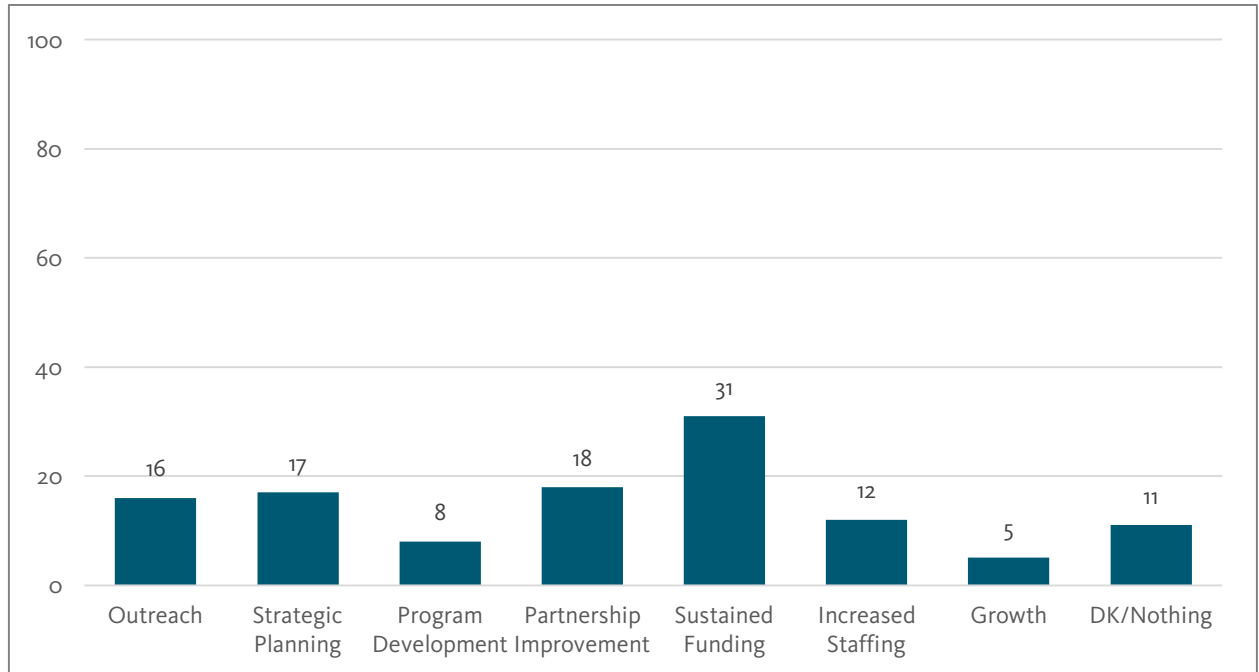
Figure 6. One change that would make the STEM Hub more successful (% of respondents). For descriptions of each of the codes, see the Technical Appendix.

When respondents were asked what excited them most about working with the Hub, they mentioned engaging students, experiencing more generally the overall impact of the Hub (and specifically, the collective impact of the Hub), networking with others and experiencing community around STEM learning and teaching, and being connected or engaged with the Hub in general (Figure 7).

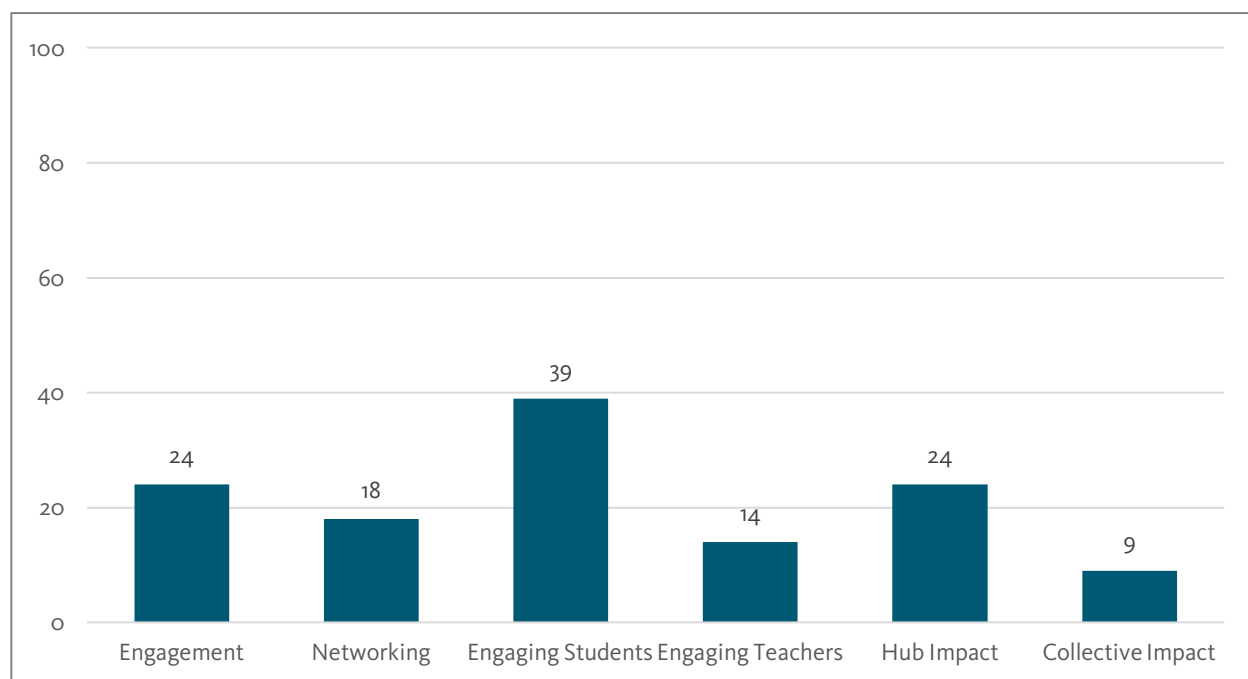*Figure 7*. What makes you most excited about being engaged in the STEM Hub (% of respondents)? For descriptions of each of the codes, see the Technical Appendix

Development of a Local STEM Learning Ecosystem as a Result of STEM Hubs

Several lines of inquiry helped us describe the formation of local STEM learning ecosystems as a result of STEM Hubs: level of agreement amongst STEM Hub staff and partners of what each STEM Hub "is all about" (i.e., the perceived focus of each Hub as described by those most involved in it), nature of the partnerships, and descriptions of how they would describe their Hub to the Oregon Governor in a conversation (another potential measure of the key focus of a Hub). Results from this analysis allow Hubs to determine whether the perception of their Hub is aligned with their strategic goals, provide the state with a potential gap analysis that can focus future investments or guidance to the Hubs, and provide policymakers with a simple "narrative" of what their investment in STEM Hubs is trying to accomplish regionally and across the state.

> "[The Hub] is bringing siloed efforts around STEM education and career pathways into the same room [to discuss how different entities are] aligning and working together."
> – Central Oregon STEM Hub Partner

Respondents were asked "what their STEM Hub was all about" by choosing from a variety of statements those which represented priorities for their Hubs. Table 1 (below) summarizes the results for the seven STEM Hubs for which we had more than 10 responses per Hub. Note that the table indicates on which areas Hubs are perceived by staff and partners to focus, as indicated by high (>75%) agreement rates on those areas where a Hub seems to focus, or low

rates (<25%) for something that a Hub is agreed to not focus. The table also indicates where those involved in a Hub seem to disagree whether their Hub is focusing on it, as indicated by rates that fall in the middle, somewhere between 40 and 60 percent. The latter case may indicate that the Hub does not yet have a clear identity around that statement (and focus), that it is not widely or commonly known that work is being done around a topic or issue, or that Hubs have developed sub-communities that focus on different issues.

Across all Hubs, improving K–12 STEM Education, preparing students for STEM careers, and providing teacher/educator professional development ranked high as key aspects for Hubs. Reaching underserved populations and supporting local STEM workforce development rated slightly lower, but were identified across all hubs as relevant. More disagreement was shown across the other statements; according to respondents, five out of seven STEM Hubs seem less focused on "increasing graduation rates" and "providing early learning experiences", and two STEM Hubs seem to not focus much on "improving or providing CTE." Several of the Hubs had categories in which 90% or more of respondents agreed that that is a major focus of the Hub. These numbers indicate a very high agreement amongst Hub's members on key goal of the Hub.

> "The STEM Hub is centered on teacher professional development and it is also becoming really centered on project-based learning."
> – Greater Oregon STEM Hub Partner

Table 1. What Is Your STEM Hub All About? (% Responding Yes)

STEM Hub	Prep students for STEM careers	Improve K–12 STEM education	Increase graduation rates	Reach under-served communities	Provide/ improve CTE	Provide early learning experiences	Improve out-of-school learning	Provide teacher PD	Provide local STEM workforce development
Central Oregon	77	80	46	69	58	37	71	66	77
East-Metro	69	69	39	85	69	23	54	69	62
Frontier Oregon	87	97	73	92	62	65	65	89	78
Greater Oregon	62	85	39	54	46	31	46	77	54
Oregon Coast	79	90	47	58	63	58	68	79	58
Portland Metro	90	100	43	87	40	23	90	97	67
South Metro-Salem	95	100	84	95	63	37	63	90	79

In areas where data indicated a strong agreement in the Hub, interview data often reflected that agreement. Respondents clearly articulated some of the strengths and major foci of the Hub. A Greater Oregon STEM Hub partner reported that "the STEM Hub is centered on teacher professional development and it is also becoming really centered on project-based learning." A Portland Metro STEM Partnership partner also noted, "PMSP is super strong in teacher PD offerings. They've done a terrific job in terms of out of school providers in our area to maximize the limited resources that folks have, find strengths, help with networking, and [provide] more opportunities for education for our students."

Conversely, when data showed a lack of agreement (or lack of awareness) about the main foci of the Hub, the interview data generally backed these ideas up. We discussed these ideas with some of the STEM Hubs in individual sense-making sessions, and in many cases STEM Hubs were already working toward improving communication and clarity within their Hub. Other feedback from STEM Hubs included that many of the partners taking the survey worked mostly in their own area and had that one perspective when taking the survey, thus they may not have been considering or aware of the Hub's broader goals.

When asked in open-ended questions about the nature of the partnership between their organization and their STEM Hub, the majority of partners across the STEM Hubs mentioned that their organization provides students with opportunities for STEM learning in general

(other than CTE), followed by general support for the Hub, various types of support for teachers, career development opportunities for students (i.e., allowing students to know what careers might be available to them), and specifically providing career and technical education for students (see Figure 3). Much of the CTE capacity mentioned in the survey was concentrated in one Hub, the Central Oregon STEM Hub (6 of the respondents who mentioned CTE came from that Hub). The other four respondents who mentioned CTE contributions were scattered across four other Hubs. About three percent of partners responded that their organization specifically focuses on addressing issues of diversity and inclusion in their respective Hubs. About half of the partners reported their partnership as supporting the STEM Hub (43%) and about one-third (36%) as benefiting from the STEM Hub.
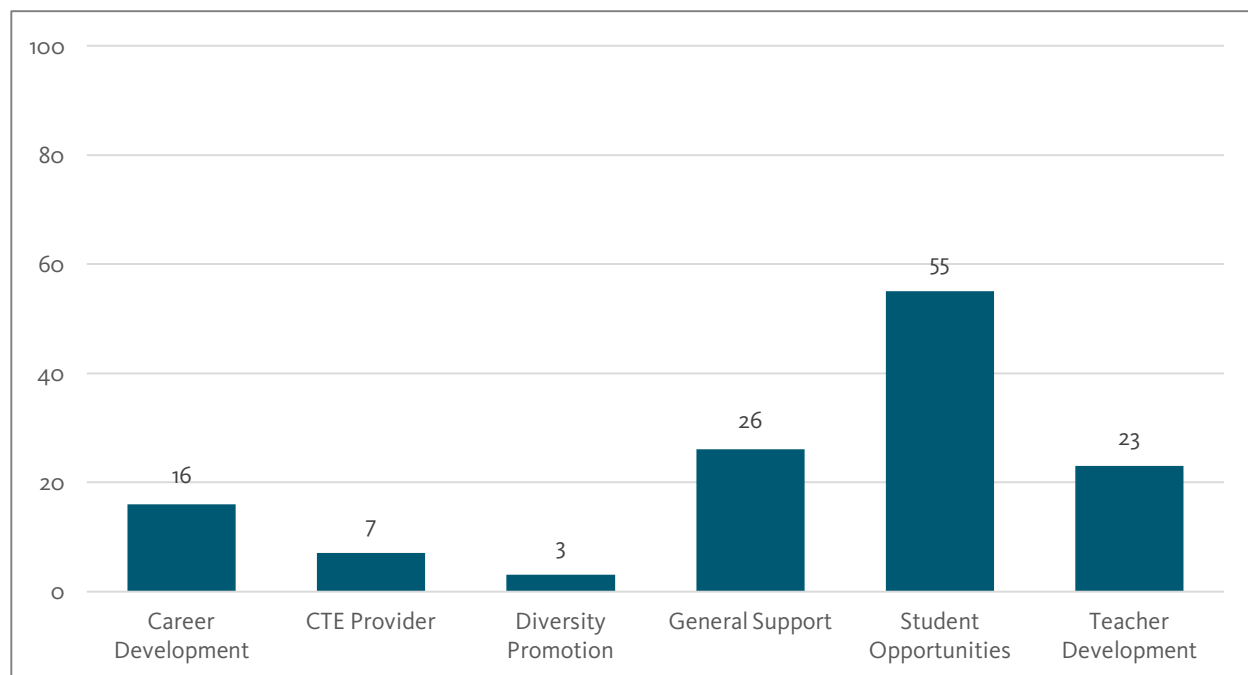

Figure 8. Nature of partnership with the STEM Hubs (% of respondents). For descriptions of each of the codes, see the Technical Appendix.

Development of STEM Hubs as Connected and Healthy Communities

For the purpose of this study, we developed a measure that captured in various ways how much respondents felt they could or were contributing to their respective STEM Hub and how much they saw their STEM Hub and its partner organizations (and members) as trustworthy and productive partners. We interpret this measure as indicator for the health and connectedness of the community that underlies a STEM Hub and coined this measure *Connection.* It is based on a 14-item scale, i.e., 14 different questions, the answers to which provided us with one strong measure. Figure 9 shows the mean percentage of responses in across the five answer categories (from strongly disagree to strongly agree) across all 14 items that form the scale. The combined results across partners and backbone staff ("Total") shows that there was about equal agreement or strong agreement across all items, and very little

disagreement, indicating that the Hubs are perceived as inclusive and safe spaces overall. Backbone staff rated the health of their Hub higher than partners (see Figure 9). Note also that the scale means for the 14 items combined showed a difference between backbone staff and partners in their responses, but that overall, with means of 4.50 and 4.11 for backbone staff and partners, respectively, both groups had generally positive responses to the questions about connections being developed as part of the STEM Hub.
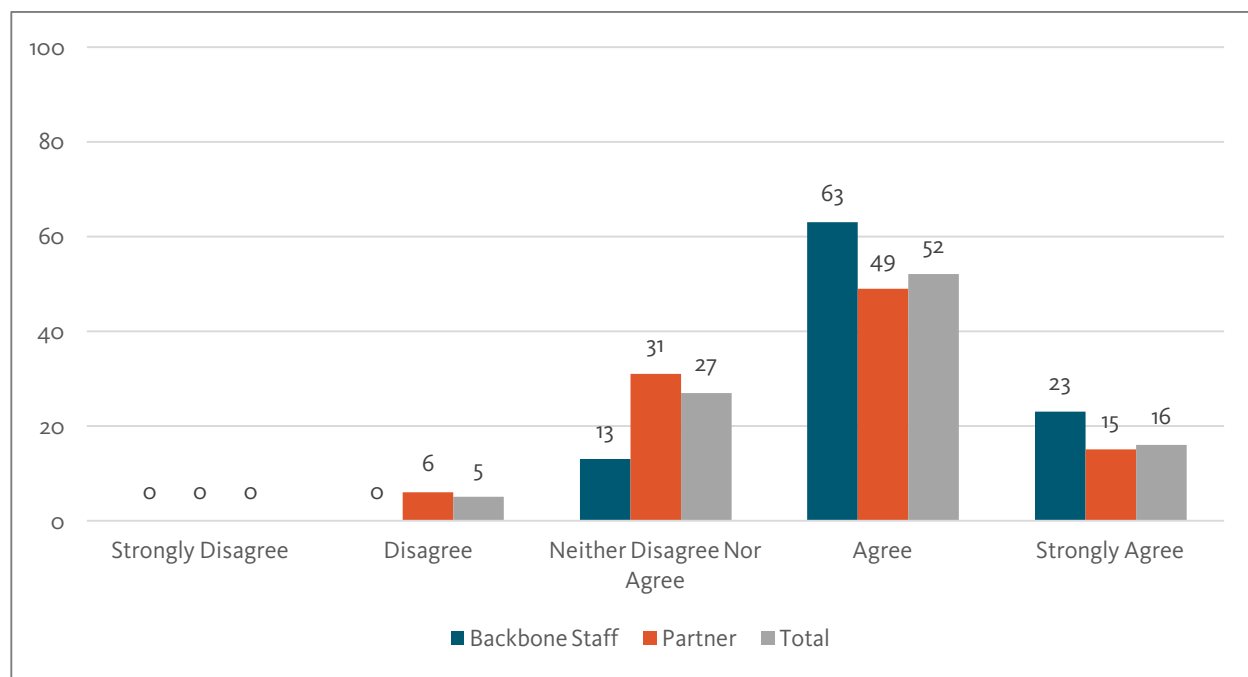

Figure 9. Connections of the STEM Hubs. Represented here are the mean percentages in each of the answer categories (strongly disagree to strongly agree) for Hub staff and partners across all Hubs. The figure indicates that, overall, Hubs have developed positive and healthy communities. The average rating on the 14-item scale that measure connections was 4.50 for backbone organization staff and 4.11 for Hub partners.

To examine how STEM Hubs are connecting to other networks, survey respondents were asked if, in the past year, they had interacted with those outside of their own Hub. We sought to examine if Hubs are isolated and without much informal flow of information and exchange of ideas, or if STEM Hubs are well connected through their members, such that we can assume cross-fertilization and informal coordination and information flow. Figure 10 reports the percentage of STEM Hub participants who, in the past year, have connected to any Oregon STEM Hub other than their own (Inter-Hub Connection), to any RAC (RAC Connection), or any Early Learning Hub (Early Learning Hub Connection). Finally, the last bar reports the percentage of Hub participants statewide who have at least one connection with any of these three (Total Connection). Note that across all Hubs, 69% of participants have at least one connection to another network, but that those who have connections tend to be connected mostly to only one other network, and some to two.
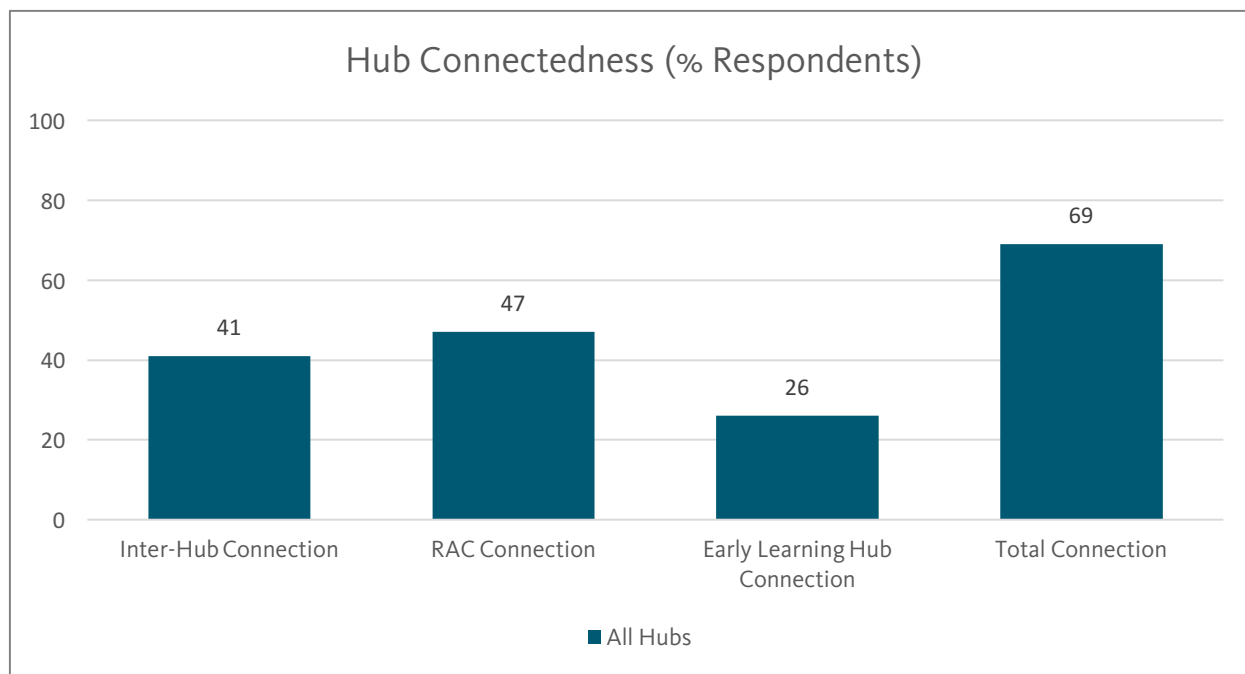
Figure 10. Percent of respondents who, in the past year, have connected to any other Oregon STEM Hub, to any RAC, or any Early Learning Hub, and percent of respondents who have connected to any one of those three groups (Total Connection).

Connections Among the STEM Hubs

Table 2 provides an overview of interactions that existed between individuals of seven STEM Hubs. One new Hub (Frontier) has had minimal interaction with only one other Hub so far, but we can see that nearly 50% of staff and partners of the South Metro-Salem STEM Partnership, the Portland Metro STEM Partnership, and the East-Metro STEAM Partnership interacted, indicating considerable flow of information and experience among these Hubs that share a smaller geographic area as well as those that include Hubs that are older and more established.

Table 2. Answers to "Which of the Following STEM Hubs Have You Interacted With?" for Seven of the STEM Hubs With > 10 Responses

STEM Hub	Central Oregon STEM Hub	East Metro STEAM Partnership	Frontier Oregon STEM Hub	Greater Oregon STEM Hub	Oregon Coast STEM Hub	Portland Metro STEM Hub	South Metro-Salem STEM Partnership
Central Oregon	x	6%	0%	6%	11%	17%	11%
East Metro	0%	x	0%	0%	0%	54%	31%
Frontier Oregon	0%	0%	x	8%	0%	0%	0%
Greater Oregon	8%	8%	15%	x	15%	23%	8%
Oregon Coast	50%	5%	11%	5%	x	21%	11%
Portland Metro	20%	60%	20%	17%	30%	x	53%
South Metro-Salem	5%	32%	5%	5%	11%	47%	x

Conclusion

STEM Hubs are perceived as valuable entities that promote regional STEM Hub activities and collaboration in and between schools, community organizations, and business and industry. Importantly, preliminary data indicate that Hub-supported student STEM learning experiences as well as partnerships with community organizations would not have been possible without leadership and resources from the local STEM Hub. However, there are some potential challenges. In particular, funding issues—including the timing, amount, and sustainability of state funding to support STEM Hub activities—are at the forefront of the minds of STEM Hub leaders and partners alike. It is clear that STEM Hubs are beginning to play a vital role in the regions they serve, and that regional STEM Hubs have been particularly effective at representing the unique needs across the diverse cultural and geographical landscape across Oregon.

> "There was NOTHING like this in our region prior to the Hub. It has brought schools, communities, students, and ideas together in our region. I can see the wheels turning in so many of our students, at such an early age. There has also been a side effect of greater positive outlook among our students, knowing there are possibilities that await them after or even before high school graduation."
> – Frontier Oregon STEM Hub Partner

A major focus of the current research effort is to help STEM Hubs build internal capacity within and across their organizations; to that end, we are reporting on the successes and challenges associated with capacity building, with the goal of highlighting evidence-based recommendations and best practices which include guidance to improve implementation of the STEM Hubs and challenges associated with decision making, influence, and communication within the STEM Hubs.

Key Findings

- The design of STEM Hubs is tied to **multiple conceptual frameworks** that are themselves based on established theory for learning and for creating social change. We therefore find that the design principles of STEM Hubs can be considered research-based.

- Partners and backbone staff across all STEM Hubs agree that **K–12 STEM education** is a main focus of their work. How they approach this main goal differs somewhat among the Hubs and represents local or regional priorities.

- Hubs differ in regard to their focus on **Career and Technical Education (CTE)**, which is the focus of some but not as strongly developed in others. The same is true for early learning, which tends to be less of a focus for most Hubs (or may not be as strongly identified as a focus by partners). Since Hubs overlap in some communities with Early Learning Hubs or Regional Achievement Collaboratives, early learning initiatives or CTE education might be addressed by those other entities.

- Other areas of focus for STEM Hubs included preparing students for STEM careers and providing teacher/educator professional development. It can and should be an opportunity for discussion for some Hubs to clarify and communicate about the main foci of their Hub as data showed some lack of agreement (or lack of awareness) of the main foci of the Hub.

- Partners and backbone staff of STEM Hubs are reporting **positive change** as a direct result of the Hubs, even those from the second cohort, which was only recently funded. Direct benefits included more and improved STEM programming for children, support for teachers and other educators, improved coordination and cooperation between local partners, or better communication between partners and between STEM education stakeholders and the wider communities of the Hubs.

- Direct positive change in new Hubs is mostly reported in the area of **communication**, indicating that the process of forming Hubs itself played an important role in community building.

- STEM Hubs are reporting a wide variety of ideas for promoting further success of their respective STEM Hubs. Although **sustained funding** and **sufficient staffing** together were mentioned the most, other aspects such as improved external communication and outreach to better embed the Hub into its community, strategic planning to further focus the Hub, improvements to the partnership arrangement, or developing more programs were also mentioned, as was that Hubs were working fine and did not need any improvement at all. There are no silver bullets for strengthening Hubs at this time, but there are many ideas that emerged from the surveys and interviews that Hub leaders can make use of in their process of continuous improvement.

- Overall, STEM Hub members are reporting **positive connections** within and across STEM Hubs, indicating that the communities of the STEM Hubs are developing. Overall, partners and (more so) backbone staff report that they can make positive contributions to the Hubs, and that they developed trusted relationships between partners and between partners and the Hub's leadership. Measures of the Hub's "health" (i.e., the degree to which individuals have voice within the Hub and trust other members of the Hub) score high. However, data also indicate the need in some Hubs to ensure that all partners be fully included in the Hub's community.

- Initial evidence exists that at least some more established and adjacent STEM Hubs are making connections between each other, and between STEM Hubs, Early Learning Hubs and Regional Achievement Collaboratives. Connections among STEM Hubs and between Hubs and other networks are ultimately needed to ensure some form of "diffusion of innovation" in Oregon, and to create a **statewide community** that can be leveraged for improving STEM education and can act as a voice for education in the public sphere. Many STEM Hubs expressed interest in further developing their connections among these networks, but stated a need for the State to facilitate this with greater support.

- Many STEM Hub activities and collaborations in and between schools, community organizations, and business and industry would not have been possible without **leadership and resources from the local STEM Hub.**

- STEM Hubs were excited to engage with OSU and EPIC in sense-making sessions where we reviewed data from their STEM Hubs with them. Many of the STEM Hubs expressed interest in continuing this type of data collection in order to get **regular feedback** that can help them **improve and monitor** their progress, and all expressed interest in connecting with other STEM Hubs on a regular basis to get and exchange ideas for strengthening their own Hub.

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Technical Appendix

This section includes a description of the research methods and data collection instruments used in this study.

Identification of Partner Organizations

STEM Hubs identified a list of partner organizations in three main categories—education, business and industry, and community. Using this list, STEM Hub leaders were asked to identify two lists of partners using the instructions below:

- List #1: Please indicate the three partners with which you collaborate and interact with most directly and frequently. For the three partners you have selected, please provide the name of a contact person and e-mail address; the project team will contact these partners in the winter to schedule a brief interview to discuss in greater detail your Hub's successes as well as to identify opportunities to improve collaborative efforts.

- List #2: Please use this list to help you generate a list of partners that have been directly engaged as part of your STEM Hub in the past 12 months. You may invite as many as you would like to take the survey, but please make sure to indicate the number of individuals you plan to invite from each organization so we can help you track survey responses. This list would exclude organizations whose primary role involves providing monetary or in-kind donations to your Hub.

Survey Development

The survey used as a primary data collection instrument in this study was developed as a composite of multiple approaches to documenting the development of a community as a collaborative structure. Most of the survey questions utilized by EPIC came from the Collaboration Assessment Tool (CAT), which has been developed, tested, and used successfully in similar organizational settings and is intended to provide feedback to organizations on various dimensions of effective collaboration.[13] Additional items were researcher-developed and/or based on items used in previous studies. The Connection subscale was developed based on a similar study investigating development of an Oregon regional collaborative.[14] In order to better understand the context of the partnerships in each STEM Hub, we also asked a set of open-ended questions that allowed both STEM Hub backbone staff and partners to provide additional information to supplement their responses to the Likert-type questions. The open-ended and partner survey questions were adapted—using developmental evaluation principles—from a previous similar study at one Oregon regional achievement collaborative.

The survey was administered to both STEM Hub backbone staff and selected partners using an online format and was designed to be completed in 15–30 minutes, depending on the partner's

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[13] Marek, Brock, & Savla, 2015
[14] Alan Daly, pers. comm. 2016

level of interaction with the STEM Hub. A link to the survey was provided to the STEM Hub leaders and thus distributed to their extended staff, where applicable, and partners for completion. The first portion of the survey included closed-ended items adapted from the CAT as well as sets of questions developed by the research teams on Data Use and Connection. Survey respondents were asked to rate how much they agreed with each item using a set of five Likert-type response choices (1 = *Strongly Disagree* to 5 = *Strongly Agree*). The CAT, Data Use, and Connection questions were not displayed to those partners who reported interacting with the STEM Hub once every quarter (or less frequently), in order to limit these questions to those partners who were best able to report on features of the STEM Hub as well as to reduce respondent burden. In our analyses, we only included those respondents who completed 50% or more of the survey. The number of respondents included in analysis for each STEM Hub are presented in Table A1.

Table A1. Completed Survey Responses by STEM Hub and by Role

STEM Hub	STEM Hub Leader / Backbone Staff	STEM Hub Partner	Total
Central Oregon STEM Hub	6	29	35
Columbia Gorge STEM Hub	2	7	9
East Metro STEAM Partnership	1	12	13
Frontier Oregon STEM Hub	2	35	37
Greater Oregon STEM Hub	4	9	13
Lane County STEM Hub	1	1	2
Oregon Coast STEM Hub	7	12	19
Portland Metro STEM Partnership	4	26	30
South Metro-Salem STEM Partnership Hub	4	15	19
Southern Oregon STEM Hub	1	2	3
Umpqua Valley Regional STEAM Hub	2	2	4
Total	34	150	184

Timing and Dissemination

The survey was constructed using Qualtrics software and was designed to be completed online using a dedicated survey link. This link was sent directly to STEM Hub leaders on October 25, 2016, with instructions to share the survey link with representatives from the partner organizations they had identified earlier. The survey was closed on March 3, 2017 and no further responses were accepted.

Partner Interviews

Acknowledging that survey responses can sometimes mask important subtleties and the unique contexts of each Hub ecosystem, the project team conducted short phone interviews separately with Hub partners in order to better understand the strengths and needs of each STEM Hub from different perspectives. Interview participants were nominated by STEM Hub leaders and contacted by the project team. Partner interviews are currently still in the process of being conducted, and the results of the interview analyses will be included in the final report.

The project team developed an interview protocol designed to gather information regarding each STEM Hub's backbone structure, ecosystem, and examples of positive collaboration and partnership from a partner organization perspective.

Each partner was asked four open-ended questions that were developed to elicit open-ended responses that would provide a richer context behind the collaboration between the partner organization and the STEM Hub:

1. Imagine you have a chance to have a cup of coffee with Governor Kate Brown, and she asks you about your STEM Hub, what it is and what it is good for. What do you tell her?

2. What is the value added of your STEM Hub? That is, what exists now that didn't (or wouldn't) exist before your STEM Hub?

3. What is something your STEM Hub really needs and doesn't have yet (or needs to expand on or improve) in order to fulfill its potential?

4. Can you provide specific example(s) of successful partnerships between your organization and the STEM Hub?

Sample Sizes and Analysis Plan

Data presented in this report reflect 184 valid responses from both STEM Hub partner organizations and STEM Hub leaders and backbone staff. Forty-five responses were excluded because survey progress was less than 50%.

Open-ended data were analyzed and summarized thematically. See Table A2 for a description of the coding categories. Given the small sample size, quantitative data were analyzed using simple descriptive statistics.

Table A2. Descriptions of Codes Developed for Survey Qualitative Item Analysis

In a few sentences, please describe the nature of your organization's partnership with the STEM Hub.
Partnerships characterized as **General Support** offered no specific focus and often noted supporting the Hub's efforts when needed. **Teacher Development** refers to both increasing opportunities for professional development in training and networking as well as improving existing opportunities. **Diversity Promotion** specifically targets increasing underrepresented groups' participation in STEM (girls, minorities, etc.). **Student Opportunities**, like teacher development, refer to creation of new programs as well as increased capacity and improvement for existing opportunities. **CTE Provider** refers to those who offer CTE opportunities within the Hub. **Career Development** refers to introducing STEM careers to younger students as well as increasing training and education opportunities specifically to guide and prepare students for STEM careers.
Please provide one example of positive change in your community as a direct result of the work of the STEM Hub.
Communication refers to improved opportunities for general interaction with other partners in the Hub. **Collaboration** refers to improved opportunities for planning, data sharing, etc. that might lead towards joint work. **Implementation** refers to creating new, or further developing existing programming, sharing of physical and monetary resources, etc. [Communication, Collaboration and Implementation were constructed as categories of increasingly more actionable interaction between Hub partners]. **Increased Awareness** refers to higher visibility of STEM and STEM education efforts in the region. **Resources Access** refers to both physical resources (e.g. equipment) and monetary resources that were not available to organizations/individuals prior to the Hub's existence. **Student Programs** and **Teacher Professional Development** both include creation of new opportunities, as well as improvement and expansion of existing opportunities.
What one change would make the STEM Hub more successful?
Outreach refers to communication with those outside the Hub and promoting the Hub's efforts. **Strategic Planning** refers to focusing the Hub's efforts and establishing or clarifying the Hub's sense of direction. **Program Development** refers to creating new opportunities for partners or the community within the context of the Hub. **Partnership Improvement** focuses on enhancing cooperation between partners and the Hub. **Sustained Funding** refers to both increases in available funds, as well as longer-term, more stable funding opportunities, often with hopes for less competition. **Increased Staffing** refers to expanding the capacity for Hubs to hire more backbone staff. **Growth** generally refers to additional time needed for the Hubs to develop partnerships and establish themselves, as well as expanding the scope of the Hub over time.
What makes you most excited about being engaged in the STEM Hub?
Engagement refers to being involved in and contributing to the work done in the Hub in general. **Networking** focuses on making connections with others within the Hub. **Engaging Students** and **Engaging Teachers** both refer to working with and impacting those groups, specifically, rather than the community at large only. **Hub Impact** refers to the direct effects that come from the Hub's contributions to the community. **Collective Impact** refers to the collaborations that allow groups to be more influential together than they would as individuals.