Theory of Action for the Mid-Columbia STEM Education Collaboratory

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The objective of the Mid-Columbia STEM Education Collaboratory project (Collaboratory) is to design, implement, and mature a local STEM education collaboration zone that impacts the educational ecosystem and serves as a model for amplifying and accelerating progress in addressing STEM education and workforce challenges. A key tenet of the Collaboratory is the belief that individual educational entities in the public and private sectors can accomplish more by working in concert with one another than by working independently.

The overarching goals of the project are to realize greater student success, enhance educator effectiveness, and mobilize community support for STEM education. As a result, local students, educators and community members will have greater knowledge of STEM and be able to apply that knowledge to inform personal and community decisions; more students will decide to pursue post-secondary education in STEM fields and/or enter STEM careers; and more students, educators and community members will actively engage in STEM education efforts in their communities. To realize these goals, STEM literacy must be enhanced, expanded, and extended to more individuals; STEM-related capabilities in the workforce must be strengthened; and parents, business leaders, educators, and the public must know about and come to value the contributions of this enterprise to the general public.

These tasks are accomplished through a combination of efforts among internal Collaboratory teams and funded/sponsored projects that:

- identify and target gaps in local STEM education opportunities, both within schools and outside of schools;
- evaluate and improve community awareness of STEM education efforts; and
- research and make available tools and products that support collaborative enterprise.

Need for High-quality STEM Education

There is a need for a more coherent and connected approach to providing STEM learning opportunities in school and out-of-school settings. The federal administration has set improving STEM education as a high priority goal, linking STEM education to the economic stability of our nation, stating "The United States has become a global leader, in large part, through the genius and hard work of its scientists, engineers and innovators. Yet today, that position is threatened as comparatively few American students pursue expertise in the fields of science, technology, engineering and mathematics (STEM)—and by an inadequate pipeline of teachers skilled in those subjects" (USDOE, 2014). The Department of Education goes on to cite discouraging statistics regarding the number of capable students who follow up with careers in a STEM field, such as "Only 16 percent of American high school seniors

are proficient in mathematics and interested in a STEM career. Even among those who do go on to pursue a college major in the STEM fields, only about half choose to work in a related career. The United States is falling behind internationally, ranking 25th in mathematics and 17th in science among industrialized nations. In our competitive global economy, this situation is unacceptable" (USDOE, 2014).

Washington state has also established initiatives to improve educational offerings around STEM. As Governor Inslee put it, "STEM-based industries such as computer science, aerospace, agriculture, clean energy, life sciences and advanced manufacturing are the backbone of our state's innovation economy, but we can't take these industries for granted. We need to make sure our education system is keeping students ahead of the curve and providing employers access to a world-class workforce "(Washington State, 2014).

In late 2012, the Office of STEM Education at Pacific Northwest National Laboratory (PNNL|Battelle) began conceptualizing the Mid-Columbia STEM Education Collaboratory to address these local needs. The Collaboratory officially launched in late 2013.

Benefits of a Collaboration Zone

Founding members Delta High School, the Southeast Washington Leadership and Assistance for Science Education Reform (LASER) Alliance, the Yakima Valley/Tri-Cities Mathematics, Engineering and Science Achievement Center (MESA), and PNNL|Battelle adopted the "collaboratory" concept as a zone or network of independent entities focused on collaboration to investigate the potential of new educational efforts in STEM education. As described by Wulf (1989), *collaboratory* is a blending of the words "collaboration" and "laboratory:" To *collaborate* means to work together, and a *laboratory* is a place (real or virtual) where one can test, analyze and demonstrate a theory of action, techniques and/or methods. Cogburn (2003) further clarifies the concept as "a new networked organizational form that also includes social processes, collaboration techniques, formal and informal communication, and agreements on norms, principles, values, and rules."

The purpose of this approach is to create a zone of collaboration in which founding members, through Collaboratory projects and operations, co-design, co-deliver, and evaluate efforts to result in (1) a broader spectrum of students being immersed in STEM learning experiences that parallel how scientists, engineers and mathematicians conduct inquires, solve problems and expand knowledge, feature community partnerships that connect academic learning to the world beyond the classroom, and prepare students to succeed in post-secondary education, careers and citizenship, and (2) educators and community members demonstrating the awareness, desire, knowledge, and abilities that yield and sustain "best-in-class" STEM education programs for all students.

The benefits of this approach, compared to members working independently, involve shared technical and organizational expertise, improved coordination of joint activities, reduced communications overhead, and accelerated development of new projects. Collaboratory-initiated projects and operations have the potential to amplify and accelerate the impacts and outcomes of its members by increasing their impact in the Mid-Columbia region (and perhaps beyond). Technical and organizational expertise are in relatively short supply and often require time-consuming research to identify individuals with particular qualifications. Collaboratory members benefit when contacts and experiences are shared with one another. By working together to coordinate event dates, identify target audiences, and publicize activities, members help one another get the word out and optimize

attendance at all of their educational events. In addition, establishing a regular communications channel among members facilitates conveyance of both Collaboratory and individual information, while regular sharing of plans, activities, and experiences helps members identify areas of need and opportunities to build on earlier efforts of other members.

Founding members envision the Collaboratory as a replicable model that could be implemented in other regions that (1) have an established base of STEM enterprise, (2) appreciate and value the contribution of local educational institutions, and (3) want to build a relationship among industry and educational entities. The model can also be effective for enhancing and expanding existing industry-school relationships into successful collaboratory structures. Artifacts generated by the Collaboratory, such as the Logic Model, Business Plan, Theory of Action, and Evaluation Reports, can help guide others to develop a similar organizational structure.

How Goals Will Be Achieved

Collaboratory activities are enacted in three phases:

1) establishing a collaborative vision and goals,
2) launching Collaboratory activities, and
3) implementing, maturing and sustaining Collaboratory efforts, starting with piloting new STEM education efforts inside and outside of school settings.

Establishing a Collaborative Vision and Goals. The first task of the Collaboratory was to link local STEM education efforts and start to build on them. Representatives from Delta High School, LASER, MESA and PNNL|Battelle met monthly as a Design Team to identify and advance common goals. The expected outcomes of this collaborative effort are:

- a finite collection of goals for the Collaboratory;
- more efficient and effective uses of resources for engaging more students, educators and community members in STEM education programs, compared to when founding members worked independently; and
- members will become more well-known and respected in the local community.

The longer term impacts of this task involve more students, educators, and community members, from more diverse groups, participating in local STEM education efforts. In addition, local educators and community members will become more aware of effective strategies for collaborating together to improve teaching and learning in STEM education.

Launching Collaboratory Activities. Once the collaborative vision, mission and goals were established, the Design Team continued their work designing, planning, and recruiting Collaboratory members with specific roles, responsibilities and deliverables. The Mid-Columbia STEM Education Collaboratory was officially launched in October 2013 with funds to establish three pilot projects to commence in January of 2014. As a result, multiple new STEM education and community programs are operating in the Mid-Columbia region, providing opportunities for more local students, educators, and community members to participate in new or improved STEM education programs. Also, Collaboratory participants share what they are learning about building, sustaining, and expanding collaborative efforts in STEM education.

Piloting New STEM Education Efforts Inside and Outside of School Settings. The pilot Funded Projects engage in researching local needs and then implementing, testing, and studying a

variety of STEM education approaches in local schools and community programs. In turn, local educators and community leaders are becoming more aware of best practices for teaching and learning STEM in schools and the community and community members are experiencing higher quality STEM education programs. Over the longer term, local students, educators and community members will:

- develop greater knowledge in STEM and be able to apply that knowledge to inform personal and community decisions;
- decide to pursue post-secondary education in STEM fields and/or enter STEM careers; and
- actively engage in STEM education efforts in their communities.

Sustaining This Work

For a minimum of five years (2013-2017), PNNL|Battelle will provide the backbone for leadership and daily operations of the Collaboratory, including leadership and funding of initial pilot projects and operations workgroups.

Beyond the initial PNNL|Battelle commitments of "time, talent and treasure," there is an intent that Funded Projects that produce promising results will position the Collaboratory to attract internal investments or commitments and/or to compete for and win external grants or contracts from federal, state or local organizations, agencies, business and foundations, allowing the Collaboratory to scale up its efforts. Promising projects, whether operational or a Funded Project may also garner further investment from PNNL|Battelle sources.

Limitations and Constraints

Collaboratory members recognize and address several limitations and constraints on their work. First, expectations must be managed. This involves clear communications to key stakeholders to reduce inconsistent assumptions and clarify the goals and timelines of Collaboratory work. In this case, *key stakeholders* are the participating employees and staff of the founding organizations plus the leadership of those organizations. The Collaboratory produces and maintains a number of documents to serve this purpose including a Business Plan, a Logic Model, and a Theory of Action (this document). Second, functional needs must be identified and staffed. To accomplish this, founding members clarify organizational needs and Funded Projects identify project-based needs, and each seeks out appropriate expertise to fulfill those needs. Ideally, expertise is also cultivated within the Collaboratory as members learn through experience and share what they are learning with one another. When individuals with a needed expertise cannot be identified, or when qualified individuals do not have time available, plans and/or timelines are modified early in that task. A third potential threat to sustaining the Collaboratory is a significant change in leadership, either within the primary organization, or other founding organizations. This concern is greatest in the early years of the Collaboratory; over time, as the Collaboratory evolves to an official structure within PNNL|Battelle, and as more members come to embrace the vision in a more personal way, leadership will naturally emerge. A final constraint of the Collaboratory effort is sustaining the interest of a sufficient critical mass of members. The founding members work from the assumption that "seeing is believing." When key stakeholders see the benefits the Collaboratory has provided to the community, and see their own visibility in the community grow as a result of these efforts, they will be willing to continue participating and sharing resources with the Collaboratory. This evidence will be provided by operations teams and each Funded Project and detailed in periodic evaluation reports that are shared with key stakeholders.

References

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