Promoting Educational Trailheads for Youth

A Retrospect

Prepared for

OMSI

By

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Project Summary

This retrospect describes efforts to promote trailheads in an afterschool program offered in collaboration between the Oregon Museum of Science and Industry (OMSI) and Self Enhancement, Inc. (SEI). This project brought together researchers and practitioners to focus on the experiences, practices and tools that could support equitable youth pathways in STEAM learning (science, technology, engineering, art, and math). This retrospect contains information on trailhead development, delivery, and improvement that can help build awareness of the promise of trailheads among program and curriculum developers.

Both OMSI and SEI are strong pillars in the Portland community and strive to support the community's confidence and skills in exploration and education. SEI began in 1981 as a basketball camp for African-American teens as a positive option for kids living in an area of Portland that was leaving them behind. It has since transformed into a resource center for youth and families, primarily African-American and those living in poverty (SEI, 2020). OMSI was founded in 1944 as a small collection of science exhibits and has since expanded community offerings to include interactive exhibits, films, a planetarium, and submarine in central Portland, and also outreach programs for schools and community groups across Oregon and in five other states in the Northwest United States (See Appendix A) (OMSI, 2020).

In this paper, OMSI staff share their perspectives on developing and promoting the pathways and trailheads through iterations of programming with SEI's middle-school youth after-school program. The paper toggles between descriptions of staff approaches to trailheads and staff learning about the application of trailheads. The paper also includes guiding principles staff recommend for future trailhead development.

Collaborating for Youth Education

OMSI and SEI began collaborating on this particular project in 2018 when SEI asked OMSI to provide engineering activities for middle-school youth. OMSI was able to fulfill this request with funding from the project *Youth Equity + STEM* (YESTEM). YESTEM was a four-year Science Learning+ partnership project (2017 - 2021) funded by the National Science Foundation (NSF). The project was intended to address fundamental equity issues in informal science, technology, engineering and mathematics (STEM) learning. Access to, and opportunities within, informal STEM learning remain limited for youth historically underrepresented in STEM (Youth Equity + STEM, 2017). The Oregon Museum of Science and Industry (OMSI) was recruited by the Institute for Learning Innovation (ILI) to participate in this project and ILI agreed that this funding could be used to support programming with SEI middle school youth.

Through this particular OMSI-SEI collaboration, the OMSI core team of the project included Marcie Benne and Chris Cardiel as project leads and Rebecca Reilly, Beth Graham, Raquel Stewart, Kim Deras and Brianna Spencer as instructors for different SEI after-school terms between 2018 and 2020. Generally, these staff members had little or no personal experience working with SEI prior to this program; however the partnership between OMSI and SEI has grown into a familial atmosphere for instructors. This team composition offered consistent collaboration and cross-pollination between the areas of (a) program development and delivery and (b) research and evaluation, with management team members additionally serving in roles related to reflective practice.

The OMSI project team met regularly to discuss progress, align thinking, and stretch and assess their approach to program delivery using input from partners and participants, new project data, team reflections, input from other SEI instructors/coordinators and OMSI instructor experiences. OMSI and ILI staff met occasionally to discuss OMSI staff experiences and reflections, information collected from youth by ILI, and the trade-offs of pursuing potential high leverage practices. Throughout this particular collaborative effort, OMSI staff communicated directly with SEI instructors and leaders through emails, texts, phone calls, and in-person interactions.

Developing a Shared Understanding of Trailheads and Pathways

The collaborative nature of this project highlighted aspects of both institutions' priorities. OMSI is dedicated to fostering STEM ecosystems of communities and partners by collaborating on the co-development of culturally inclusive STEM education experiences. SEI is dedicated to helping underserved youth realize their full potential by providing academic support and enriching programs that connect youth to their community. During OMSI's work with SEI, efforts were put forth to highlight STEAM (science, technology, engineering, arts, and math) trailheads in youth's everyday lives and the greater Portland area through the delivery and refinement of STEAM programming. The understanding gained from this project about integrating the concepts of trailheads and pathways into programming with minoritized youth, has not only informed programming offered by OMSI and SEI, but is being shared with fellow practitioners to advance the ways additional informal education experiences support youth to connect their pathways and opportunities.

As defined in the YESTEM project, STEM interest pathways are the directions learners take through their unique ecology of opportunities, including personal experiences, tools and practices needed and supplied along the path (Youth Equity + STEM, 2016). A trailhead (see Appendix B) is the intentional and visible linkage leading from one STEM learning and engagement experience to another; these linkages can highlight opportunities along pathways within or outside the same ecosystem location (Cardiel, 2018). For example, both OMSI and SEI are a part of the Portland-area STEM *ecosystem*, and a *pathway* (or, more likely, multiple pathways) exists between the two organizations that learners may pursue if they are (a) aware of the pathways and (b) interested in doing so. The role of trailheads, then, is to "clear away the underbrush" from pathways that may not be visible to all learners, including instructors. For example, a trailhead was promoted when an OMSI educator shared information about OMSI's Teen Tech Center, a tech space for youth aged 13 to 18 to explore their interests, with an SEI participant who was interested in animation. Through this trailhead, the youth became aware of a connection between STEM learning at SEI and STEM learning in the Teen Tech Center's animation studio that may otherwise have remained unknown. This notion of trailheads, incorporated with youth feedback, led project leaders to understand how youth see trailheads and the communications youth need in order to take advantage of trailhead opportunities.

Developing Courses with Trailheads and Pathways

Understanding youth interest pathways is a priority for OMSI and is essential in providing relevant trailheads; this is why OMSI staff focused on cultivating methods that pique youth interest and provide them with lasting impacts. OMSI staff, in collaboration with SEI and ILI staff, worked within the realms of the project rationale as defined by YESTEM to develop a number of prioritized outcomes and high leverage practices to guide content and delivery to youth. The outcomes for youth included (a) gain access to personal and societal power and self-determination; (b) exercise design thinking related to authentic, relevant real-world contexts; and (c) perceive their interests in STEAM not as an end, but as a means for achieving their goals.

Curriculum was developed with the prioritized outcomes in mind and with input from the youth about their interests and goals. The design-thinking outcomes were aligned according to *Next Generation Science Standards* (NGSS Lead States, 2013). OMSI's aspirational high-leverage practices included (a) collaborate with SEI instructors and youth to choose a course topic that the participants would find relevant and appealing and create a product that participants could take home to incentivize attendance, (b) use materials that were accessible to low-income youth of color and relevant to the participants in the OMSI session, (c) incorporate trailheads into every session, and (d) exercise design thinking throughout the course. Design thinking, a focal point of the program delivery and outcomes, was a priority during course planning. The application of the high-leverage practices was re-evaluated each term by the core team according to reflections and input provided by core team members, ILI, SEI staff, and youth.

Planning

Courses began with solely OMSI content and evolved with improvement of OMSI listening to include SEI staff and participants. Course topics were designed to include threads of art and science with an overall topical focus of design thinking. Courses consisted of one-hour classes facilitated by two OMSI instructors twice per week and engaging anywhere from 5-20 students per class. Participants were free to come and go as they pleased and as they found interest in the activities. Activities and trailheads were formed within logic models (see Appendices C, D, E, and F) that assisted in aligning the course with high leverage practices and prioritized outcomes. The activities were created to foster an environment where self-expression could be met in ways that were relevant to the participants' lives. During each class OMSI facilitators would share trailheads with youth that might relate to SEI (by location, interest and connection to the course). Over time we learned that asking youth directly what type of trailheads they would like to see gained more traction in youth interest.

Couse topics developed by OMSI with SEI approval:

Designing our World (Spring 2018) - Participants used the engineering design process to create various tools that would be relevant in social, medical, environmental and emergency situations. Trailheads included information about local clean energy organizations and resources.

That's Sew Electric (Spring 2019) - Participants used the engineering design process to create an electronic textile invention to solve a problem relevant to them or their lives. Trailheads included information about careers in tech and textile design including local opportunities at Nike.

Course topics developed by OMSI with strong guidance from SEI staff and youth:

Art and Light (Autumn 2019) - Participants used the engineering design process to assemble and wire a lamp from scratch using their art and engineering skills. Trailheads shared information about STEAM events in the surrounding area, including the Portland Winter Light Festival.

Science of Sound (Winter 2020) - Participants explored the ways in which sound and music are created through engineering, biological, artistic, and social processes. Trailheads included information about opportunities to attend free music lessons and music events throughout the city (See Appendices G and H).

Evaluating Courses to Improve Trailheads and Pathways

The project included a concerted effort to conduct reflective evaluation at multiple levels over the course of program implementation and refinement. After the first term, ILI created reflection documents for instructors to complete after every session. In addition, the OMSI core team debriefed each week and reflected at the end of each term. Instructors created evaluation activities for participants to complete in an ongoing manner throughout each term to capture data regarding participant interests and pathway pursuits and to assess the efficacy of trailheading by instructors. During each session, instructors collected data from participants by asking them how they felt about science and art, what they wanted to learn, what types of trailheads they wanted instructors to provide, and how they were feeling in general. The strongest connections between OMSI instructors and youth were created through get-to-know-you games, and consistent checking in, both on a group level and one-on-one with participants, a model learned from SEI's practices. Checking in with youth and including them in course planning and trailheading improved program content and delivery.

Reflections by both youth and core team members strengthened trailhead development and delivery by providing insight into participant needs and accommodating relevant factors for youth. When instructors received feedback from youth about how a trailhead sounded boring, they asked what would be more relevant to them and provided trailheads that made connections instead. Multiple youth informed instructors that trailhead opportunities which included food or pay interested them, so instructors found local events with free food, and paid internship opportunities around Portland. Youth also expressed interest in OMSI instructor jobs and working with OMSI in general. Showing up consistently became in itself a trailhead for youth as they felt more comfortable asking instructors about their lives in the museum education field.

Understanding Practices to Improve Trailheads and Pathways

Throughout each session and across the project overall, a number of challenges were encountered, ranging from OMSI instructor changes to unplanned events or occasional low participant turnout. In order to keep track of challenges and goals, instructors were asked to complete a reflection after each session, listing the activities they engaged in, the specific strategies they used to support inclusion and authentic connection with youth. Examples of such strategies were asking for youth opinions and providing culturally relevant trailheads and programming. When met with a behavioral challenge, instructors were able to lean on the support from SEI staff, usually through the help of participants' assigned coordinators. At SEI, each participant is assigned a coordinator who helps them academically and socially. The coordinators are familiar with the participants' session schedules, often meet them for lunch at school, and have strong communication with the participants' families.

Trailheading themes and opportunities were discussed and iterated in logic models created by the core team. Applying the notions of pathways and trailheads throughout the iterations of programming with SEI proved to be difficult. OMSI instructors practiced distributing trailheads verbally as announcements, by handouts, and by sprinkling them into conversations. The efficacy of trailhead delivery varied, and while instructors were able to supply trailheads, it was sometimes unknown if participants followed through with them. Conversation with participants about trailheads, however, was effective in some cases. One participant showed interest in using OMSI's Teen Tech Center and suggested that we share the information with her TRIO Upward Bound (a United States federal program designed to provide services for students from disadvantaged backgrounds) counselor to see if we could organize a trip. These kinds of interactions were the most promising in evaluating whether or not trailheads were making an impact. On a few other occasions, participants commented that they would like to go to an event or use a resource we proposed. However, instructors learned, and participants vocalized, that youth might have challenges to accessing the proposed trailheads--challenges such as time, transportation, or considerations related to their families and support networks. In addition to barriers to trailheads, at times there was also a lack of interest, as indicated by paper trailheading materials (e.g., flyers) left on the floor. If the trailhead did not seem immediately useful to participants, they lost attention. Participants cited that they wanted trailheads relating to jobs and ways to make money while gaining experience, however they also mentioned they would need help applying for paid internships, which OMSI was able to coordinate through high school programming days, which helped youth apply for summer jobs at OMSI, but they were not sustained throughout the project. The work to continue bringing trailheads to youth would require more research to discover how to break down barriers that keep youth from being able to access trailheads and to mine and create trailheads that are of interest to youth.

Summarizing Lessons Learned about Trailheads and Pathways

The effectiveness of how this project defined and implemented trailheads cannot be fully determined at this point. OMSI staff observed that work is still needed to reduce barriers that youth hit when trying to access a trailhead. We can continue to create new opportunities for youth and recognize that trailheading is a powerful, and perhaps necessary, method for offering direct and actionable signposts to additional STEM experiences. However, in the course of identifying pathways and connections, real work is needed to address existing barriers to those pathways. In support of this aspiration, our participants recommended sharing trailheads with youth counselors and coordinators, who can (and already do) plan trips and set up workshops, create tangible access for youth, and ensure trailheads are reaching youth who find them relevant. If possible, collaborating with counselors to identify pathways, develop trailheads, and plan trips together could yield effective connections between youth and opportunities.

Guiding principles for incorporating trailheads and pathways into STEAM programming

1. Collaborate with youth and community stewards to plan programs, pathways, and trailheads.
   Communicate regularly and build lasting relationships to learn more about youth and community interests and needs.

2. Foster shared understanding of trailheads and pathways among instructors, counselors, and participants so that everyone can work together to identify and implement them.
   Build on aligned aspirations for stronger collaborative efforts.

3. Build pathways and trailheads into program logic models.
   Use logic models to build coherence and accountability into educational practices. Connect activities with high leverage educational practices to cultivate effective programs.

4. Share trailheads with youth and community leaders.
   As youth suggested, involve community members who youth trust.
   Promote pathways that engage youth passions; leverage word of mouth among youth to spread news of trailheads and opportunities.
   Continue to notice and break down barriers; recognize that barriers include transportation, cost, and unwelcoming environments.

5. Continually reflect on trailhead practices.
   Create systems of information gathering and assessment to help keep trailheads relevant and accessible to youth. This also allows instructors to feel heard and united.
   Center youth voices in trailhead development. With the support of instructors, counselors, and others, they will each create unique STEAM learning pathways that are true to their learning desires and goals.
   Get creative with feedback collection techniques and do not underestimate the power of mood boards and sticky notes.

Resources

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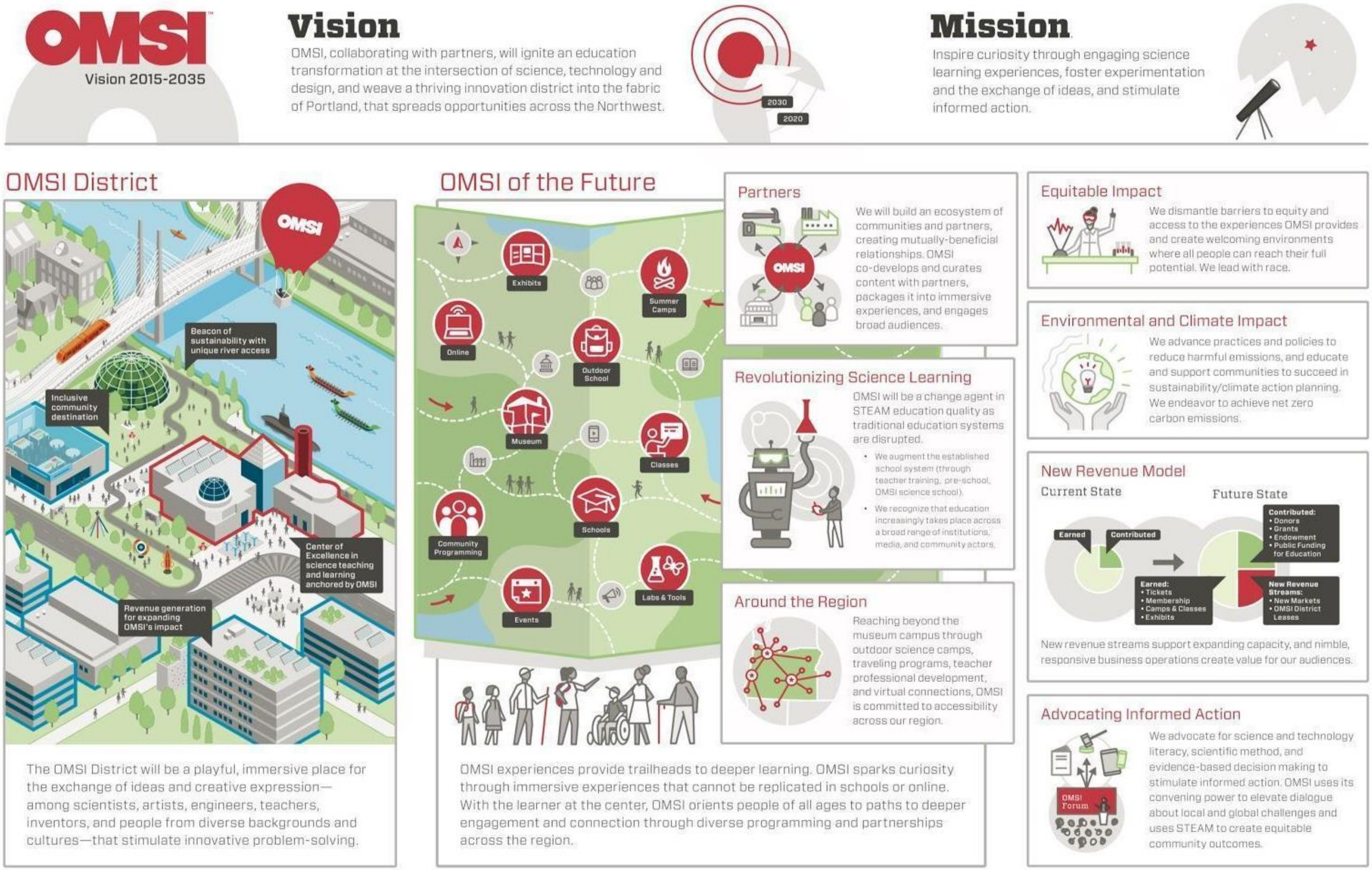
Appendix A: OMSI 20-Year Vision Map

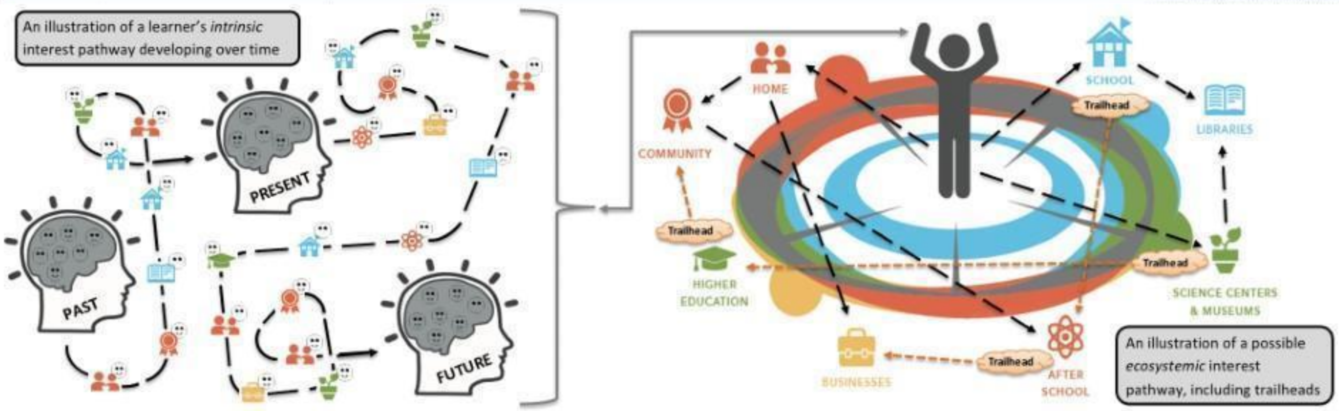


Appendix B: STEM Ecosystems and Interest Pathways at a Glance

STEM Ecosystems and Interest Pathways at a Glance

Draft last updated August 13, 2018 by Chris C.

Key Term	YeSTEM Conceptualization	Other Conceptualizations	What Does This Mean for OMSI?
Ecosystems	[The] community-wide ecosystem includes schools, but also informal spaces such as museums and community-based organizations. That is, we understand youth as interacting with, mobilising capital within and moving between settings both within and beyond ISL spaces.	A STEM learning ecosystem encompasses schools, community settings such as after-school and summer programs, science centers and museums, and informal experiences at home and in a variety of environments that together constitute a rich array of learning opportunities for young people. A learning ecosystem harnesses the unique contributions of all these different settings in symbiosis to deliver STEM learning for all children (STEM Funders Network, 2016). With a vision of STEM learning that involves improving scientific literacy, no single institution can accomplish this alone (Bevan et al., 2010; Traphagen & Traill, 2014). This complex vision requires multiple community stakeholders including schools, informal learning institutions, STEM professionals, and families. Within such a STEM learning ecosystem, these unique entities work synergistically to support STEM learning for all (Falk et al., 2016; NRC, 2015) (OMSI/High Desert Museum 2017 NSF AISL proposal draft, *unsubmitted*).	STEM ecosystems are made up of all of the sources of STEM learning and engagement that an individual may encounter in their community. These sources include (but are not necessarily limited to) the K–12 school system, science centers and museums, libraries, STEM industry, the university and college system, home and family, and other out-of-school settings. In every case, an ecosystem acts as the landscape within and through which learners make their educational journeys; however, opportunities may be enriched, and STEM learning deepened, when there is open communication and strong, thoughtful, and holistic collaboration and trailheading across different parts of the ecosystem.
Pathways	The direction one takes through a particular ecology of opportunities (Barron, 2006), that includes the experiences one has, as well as the practices and tools acquired or needed along the way to author (that is, personally create) a way into STEM (Tan et al, 2013). By their nature, pathways lead in multiple directions, including pathways towards STEM careers, as well as empowered everyday lives in STEM.	Pathways of interest development are not solely defined by a single topic or domain but instead have a complex motivational structure extending to multiple preferences and multiple aspects of an individual's life. The theory invites, and provides a vocabulary for, exploration of the complex ways adults who encounter Science Delivered might interpret these experiences, connect them with other interests and preferences, and extend the experiences in unique and idiosyncratic ways that may or may not be relevant to the STEM content (Azevedo, 2011, as written in OMSI's 2016 NSF AISL *Science Delivered* proposal). Most individuals develop interest, understanding, and an identity related to science through an accumulation of experiences from different sources at different times (e.g., Barron, 2006; Falk & Dierking, 2010; Ito et al., 2013; Lemke et al., 2012; OECD, 2012; NRC, 2009; Renninger & Riley, 2013; Stocklmayer et al., 2010). For instance, an adult science and technology learner experiences a range of different science-and-technology learning opportunities in a variety of contexts including watching television; reading books, magazines, or the newspaper; visiting a local science center, zoo, or aquarium; solving every-day problems; talking with friends or relatives; and, increasingly, from forays on the internet. From the perspective of the learner, the context in which he or she encounters science and technology may change moment to moment, but all of these experiences seamlessly contribute to stimulating and sustaining interests and motivation in a topic (Hidi & Renninger, 2006) (Falk et al., 2016).	It seems that STEM interest pathways can been viewed in two ways: as *extrinsic* (or *ecosystemic*) pathways individuals take within their holistic landscape of learning and engagement opportunities (encompassing *locations*, *activities*, and *resources*), and as *intrinsic* pathways that individuals carry within themselves and that may be sparked, maintained, or weakened by the events and opportunities encountered over a lifetime (encompassing *knowledge*, *identities*, and *attitudes* such as self-efficacy). These two ways of thinking about pathways are, in a sense, two sides of the same coin, as an individual's experience along their ecosystemic pathways will inform how and to what extent their intrinsic interest pathways are developed and sustained, while intrinsic interest pathways will guide an individual to pursue different pathways through their ecosystem of STEM education resources and providers.
Trailheads	N/A	The museum of the future is a trailhead to deeper learning and experiences. The museum is an attractor, sparking curiosity through immersive experiences that cannot be replicated in schools or online. With the learner at the center, OMSI maps and guides paths to deeper inquiry and mastery through diverse programming and partnerships across the region (OMSI 20 Year Vision, 2014).	A trailhead is an *intentional* and *actionable* linkage leading from one STEM learning and engagement experience to another, offering a clear guidepost for learners to follow if they so choose. Trailheads can either make connections across different parts of the STEM ecosystem (e.g., an OMSI coding class that brings in a Google software engineer as a guest speaker to discuss their work and share information about Google's internships) or within the same ecosystem location (e.g., a posting in a middle school's science classrooms encouraging students to join the school's robotics club). Additionally, by supporting learners in building their *STEM identity*, educators may contribute to the development and maintenance of intrinsic interest pathways.



In a Nutshell

Ecosystems:
The *landscapes* in which learning takes place, housing a multitude of educational resources and crisscrossed by pathways between these resources

Pathways:
The *connections* between resources, whether recognized and/or acted upon by learners or not, over time and through the educational ecosystem

Trailheads:
The *intentional signposts placed* by educators that draw attention to existing pathways connecting learners to additional educational resources

Appendix C: Winter 2018 Logic Model

Name	Program Overview	Challenge	Notes	NGSS Outcomes (skills, knowledge, attitudes)	Outcomes (learning, attitude, knowledge)	Potential Pathways		Potential Trailheads	
Save the Day	These activities center on STEM equity and address the need for more girls and those with diverse backgrounds to pursue engineering-related careers. These activities empower their pursuit of engineering by being social, personally relevant, and altruistic. They also intend to show the various ways in which the engineering process relates to their lives, as well as foster a positive attitude towards engineering. [Adapted from Designing Our World]	Design a simple model of an object to help someone in a disaster, and then revise the design to include constraints.	Focuses on the creative aspects of the engineering process and serves as an excellent introduction to the program.	• Asking questions and defining problems • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information	Engineers have to think about many situations while creating new things. Different people use objects differently, and people have varying needs that have to be met.	Jump-start to creativity and open-ended results. Finding solutions that are others-focused.	• Home: Fixing and/or creating new things at home; following the Engineering Design Cycle • School: Math and other STEM classes • Community: Teen Science Alliance; museum space; Summer Camps and Classes; STEM classes offered by the specific community organization	Learners are encouraged to become engineers at home by finding creative solutions to day-to-day situations and creating new things when a need arises.	An OMSI employee made SEI aware of the opportunity to purchase a non-profit museum membership for their students and staff. They are now regularly bringing in large groups of students to OMSI.
Zip Line Rescue		Design a carrier to transport an injured person down a zip line.	Includes additional challenges for added difficulty levels.	• Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Constructing explanations and designing solutions	Adaptability, altruism, engineering can be fun, engineering saves lives.	Able to improve something in the face of new challenges. Begin to realize engineering is all around us.		Introduce learners to various careers that utilize zip lines: from first responders to NASA engineers.	
Energetic Ocean		Design a model offshore wind and wave energy farm to maximize the amount of energy the farm can produce.	Based on an engineer role model's research and includes a video of a role model.	• Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information	Understand balance between cost and outcome. Utilizing resources efficiently.	Advocating for clean energy. Pursuing careers in the field of renewable energy.		Connect learners to clean energy organizations and resources.	
Surgical Solutions		Create specialized instruments for different types of surgery.	Focuses on biomedical engineering.	• Asking questions and defining problems • Planning and carrying out investigations • Constructing explanations and designing solutions	Engineering requires teamwork, engineers are altruistic.	Creating something that can be successfully used by others.		Learners are informed about Biomedical Engineering as a career option.	
Get it Together!		Plan an efficient assembly line process to put together emergency supply kits.	Concept of assembly line is purposely not introduced until students discover the process on their own.	• Asking questions and defining problems • Developing and using models • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence	Engineers need to delegate and prioritize to achieve the best outcomes.	Applying this process to daily habits (chores at home, for example) and tasks (school work, group assignments, etc.).		Field trip to Nike or other local factory can make learners visualize the real-life application of an assembly line.	

Appendix D: Spring 2019 Logic Model

Activity	Program Overview	Challenge	NGSS Practices	Outcomes (learning, attitude, knowledge)	Potential Pathways		Potential Trailheads	
Engineering Design Process	This program showcases a fun and innovative side of coding. The activities combine into STEAM – Science, Technology, Engineering, Art, and Math. Coding and sewing are embedded in a way that engages people who wouldn't normally be interested in one or the other, and the altruistic and personally relevant nature of the class will attract more girls than other similar classes.	Design a simple model of an object to help someone in a disaster, and then revise the design to include constraints.	• Asking questions and defining problems • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information	Jump-start to creativity and open-ended results. Engineers have to think about many situations while creating new things.	Noticing and using the Engineering Design Process in everyday life. Finding solutions that are others-focused.	• Home: Fixing and/or creating new things at home; following the Engineering Design Cycle • School: Math and other STEM classes • Community: Teen Science Alliance; museum space; Summer Camps and Classes; STEM classes offered by the specific community organization	Encourage learners to become engineers at home by finding creative solutions to day-to-day situations and creating new things when a need arises.	Careers in tech and textiles (e.g., Nike). Share book with more complex projects people have done with Circuit Playground. Share other functions of the microcontroller, which youth will take home and can explore after this program ends.
Sewing		Learn and practice different methods of sewing.	• Developing and using models	Creativity, experimenting, comparing, practicing hand-eye coordination.	Feel confidence to sew new things and to fix damaged items before tossing.		Sewing and fixing damaged textiles is a sustainable and environmentally friendly decision.	
Circuits		Create a working circuit on a piece of paper that powers an LED light.	• Asking questions and defining problems • Developing and using models • Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence	Creativity, cause and effect, introduction to computational thinking.	Pursue further classes related to circuits or electricity. Feel more confident in other similar subjects.		Help promote the development of this skill by reframing coding as altruistic and personally relevant. Learners get to take their Circuit Playgrounds with them at the end of class and continue using the free, online-based platform at home. Encourage learners to play with the many other sensors incorporated in their circuit.	
Coding		Program a circuit board to sequence LED lights sewn onto wearable items. The final project must solve a current problem in the user's life.	• Asking questions and defining problems • Developing and using models • Using mathematics and computational thinking • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information	Coding can be altruistic and personally relevant. In this class, coding leads to creating useful things that make our lives safer.	Discover other functions of the microcontroller. Pursue further coding classes (either at OMSI or at their school/community center). Feel more confident with seemingly complicated tech subjects, and create other sewable electric products later on.			

Appendix E: Fall 2019 Logic Model

Activity	Challenge	Outcomes (learning, attitude, knowledge)	Global Outcomes (or Impacts?)	Potential Pathways	Potential Trailheads
Art (Community Art Project)	Create an art project that reflects the personal identity of the learner; OR, create an art project as a class that reflects the various identities of the learners in the group.	Jump-start to creativity and open-ended results. Preliminary engagement in the class. Introspective. Allows for open-ended results and artistic expression in a classroom setting. Way to establish trust with students.	Participants will have increased access to personal and societal power and self-determination as the result of increased skills, knowledge, and self-confidence related to STEAM. Participants will exercise design thinking related to authentic, relevant real-world contexts. Participants will help position their interests and experiences within STEAM, not as an ends but as a means for achieving their goals.	Connections to artists who are people of color ex: Portland Art Gallery, KSMocha, Free School PDX.	Encourage learners to see and incorporate art into everyday life. Point learners towards hardware stores as a place to continue expanding creativity and creating new designs
Light (Glow in the Dark, Prisms, etc.)	Learn the basics about light, prisms, and how glow-in-the-dark works.	Draw connections between art and science. Discuss how white light contains all colors. Continue to discuss the nature of light.		Attend upcoming Portland Winter Light Festival and other OMSI classes such as: Teen Science Alliance; museum; Summer Camps and Classes; STEM classes offered by community organization or other institutions	Share promotional material for 2020 Portland Winter Light Festival and encourage students to attend.
Electricity (Batteries)	Create a working circuit on a piece of paper that powers an LED light.	Creativity, cause and effect, introduction to computational thinking. Explain how electrical circuits work in preparation for building a lamp.		Pursue further classes related to circuits or electricity. Feel more confident in similar subjects—free Arduino meetups in PDX, summer and winter classes at OMSI	Point learners towards careers in tech and electricity.
Lamp, Cords and Outlets	Design a working light using wires, outlets, and knowledge of circuits. Incorporate art into the final project to end with a personalized lamp.	Explain how electrical outlets, plugs, sockets, bulbs, and switches work. Draw connections between art and science. Can be altruistic and personally relevant.		Discover other ways to apply electricity knowledge to day-to-day life. Feel more confident with seemingly complicated tech subjects, and create other electric products later on--Multnomah County Library Rockwood Maker Space.	Learners get to take their projects home with them at the end of class. Encourage learners to use it as a model to create similar projects, or teach other people how to make one when they ask about their lamps. Draw connections between electrician, electrical engineer, and designer.

Appendix F: Winter 2020 Logic Model

Activity	Challenge	Outcomes (learning, attitude, knowledge)	Global Outcomes and Impacts	Potential Pathways	Potential Trailheads
Art and Social Justice	Play a couple of songs and analyze/reflect on the lyrics as a class. Create your own simple poem or your own freestyle rap song (optional).	Jump-start to creativity and open-ended results. Preliminary engagement in the class. Introspective. Allows for open-ended results and artistic expression in a classroom setting. Way to establish trust with students and inspire interest. Can be very personal. Exposure to experimental design thinking through discussion of research on synchronicity of dance.	Participants will exercise design thinking related to authentic, relevant real-world contexts. Participants will have increased access to personal and societal power and self-determination as the result of increased skills, knowledge, and self-confidence related to STEAM. Participants will help position their interests and experiences within STEAM, not as an ends but as a means for achieving their goals. Participants will include their caretakers and families in their learning process by having the opportunity to engage in a take home prompt or project weekly.	Exposure to local artists of color. bands, rappers, poets, etc. Information on free or reduced priced music classes: Ethos, Youth Music Project, My Voice Music and more.	Share information on open mic nights in Portland. Talk about artists that may be personally relevant and inspiring to students.
Biology of Sound	Learn the basics of sound, ear anatomy, and brain function--and how they all work symbiotically.	Draw connections between sound and science. Learn about music therapy and ways to incorporate it into everyday life. Learn the importance of ear health and physical balance.		Feel more empowered to pursue internships that will help their long-term interests in fields such as research, design, medicine and engineering.	Talk about internships and apprenticeships with community organizations and institutions including OHSU, PSU, OSU, Bonneville Power, NOAA and more that they may qualify for now and in the near future though the Saturday Academy.
Sound and Engineering	Make a shoebox guitar and make your own speaker. Learn about acoustics and wavelengths.	Creativity, learn a practical skill, and create a product using design thinking. Students take product home. Exposure to fields which students may have been previously unaware of.		Provide information on library podcast rooms, maker labs, information on sites that have software available for video and sound editing so they can continue to harness their skills.	Point learners towards learning opportunities and careers in music production or fine arts. Provide examples of famous artists who were not traditionally trained in music.
Make your own instrument	Learn about functional fixedness. Design a working musical instrument from simple materials that are easily accessible outside of class. This can be used at the showcase.	Make a paper phonograph and discuss the science behind it. Learn about everyday objects that would not normally be used to make sound and create a DIY musical instrument. Allows for creativity and connects to science topics. Discuss what instruments are part of participant's cultures.		Discover other ways to apply sound knowledge to day-to-day life. Exposure to OMSI classes to learn more about sound, physics, etc. Example: Teen Science Alliance; Summer Camps and Classes; and interactive Museum exhibits.	Encourage them to continue practicing musical/artistic/STEM interests. Share information on exhibits available at OMSI, talk about 2 dollar Sunday. Information on financial aid for classes and camps.

Appendix G: Winter 2020 Trailhead Flyer

Create and Celebrate: A Night Celebrating Black Creativity & Power

An arts showcase featuring the future—and present—of Portland's young black creative talent, featuring brand new works of poetry, live music, and dance from students from Portland Public Schools.

Grant High School

2245 NE 36th, Portland, OR 97212

Wed Feb 19, 6-8 pm

All Ages and Free!!!!!!!!!!!!!!

Updates on instagram - @friendsofnoise and @nextuporegon

Appendix H: Winter 2020 Trailhead Flyer

Teen Tech Center Grand Opening

Join us for the Grand Opening Celebration for our new Teen Tech Center!

We will have food, speeches, maker-activities facilitated by teens, and a chance to network with local tech industry folks.

This event is FREE and open to all!
JAN 31 | 5:30PM-7:30PM
Located at OMSI (1945 SE Water Ave, Portland, OR 97214) in the Turbine Hall.