Interreg

Northern Periphery and Arctic

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Arctic STEM Communities

STEM Ecosystem Community Manual

For Northern Periphery and Arctic regions

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(2024) STEM Ecosystems Community Manual for Northern Periphery and Arctic regions

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Executive Summary: STEM Ecosystems Community Manual

This manual presents the outcomes and best practices from the NPA Arctic STEM Communities project, conducted over 18 months (2022–2024) in Húsavík (Iceland), Galway (Ireland), and Rovaniemi (Finland). The project aimed to empower Northern Periphery and Arctic (NPA) communities to advance STEM education, with a focus on addressing barriers for girls and women, by adopting the STEM Learning Ecosystem (SLE) approach.

The initiative brought together education, industry, government, and community stakeholders to tackle local STEM challenges. Key pilot projects included the establishment of a STEM School Council in Húsavík to align educational efforts, the creation of a STEAM evaluation toolkit in Galway, and the launch of virtual STEM clubs in Rovaniemi to engage children in remote areas. These projects addressed challenges such as community engagement, resource constraints, and cultural barriers, while fostering inclusivity, collaboration, and impact measurement.

The project enhanced awareness of STEM opportunities, increased cross-sector collaboration, and developed sustainable models for STEM education tailored to the NPA region's unique needs. Future efforts will focus on sharing this manual widely, hosting training sessions, and continuing to address gender disparities in STEM. This manual serves as a guide for Arctic and remote communities to replicate these successes and foster positive change through local STEM ecosystems.

Aim of This Manual

This manual is designed to share the outcomes of the Interreg NPA Arctic STEM Communities project, which was conducted over an 18-month period between June 2022 and November 2024 in three partnering communities in the NPA region: Húsavík in Northern Iceland, Galway in Ireland and Rovaniemi in Lapland, Finland. The Community Manual is the culmination of this collaborative project featuring recommendations for other communities to use, built on lessons learned throughout the project and specifically best practices identified through pilot projects implementation process.

The Community Manual includes common barriers faced, resources and opportunities identified and other important information that other NPA communities, as well as communities around the world, can use to replicate this planning and implementation process.

Here the three NPA partners share the best practices, common challenges, barriers, and opportunities around the STEM Ecosystem community empowerment and pilot project process they undertook for advancing outcomes for girls/women in STEM in the three NPA regions.

This manual is a community manual; it is intended to be used by leaders in communities who wish to make positive change in their communities, whether it be advancing outcomes for girls and women in STEM, building skills for the 21st century, adapting to the effects of climate change, promoting economic development, or any other shared goals that they may have as a community.

This manual will be disseminated publicly on the project's website, on the partners websites and other locations for other NPA communities to accelerate the uptake and to serve as an empowerment to communities to build capacity for establishing their own ecosystems, identifying needs and assets, building greater cross-sector partnerships and launching projects that forge solutions to problems they face.

Training, conferences, and workshops on the use of the community manual are envisioned for future funding cycles.

Who We Are

This manual was written by the partners of the Interreg NPA project Arctic STEM Communities in November 2024. The lead partner of the project is STEM Húsavík, which through its partnering

organisation Húsavík Academic Center (LP1), applied for the small-scale project under Priority 3: Better Cooperation, within Northern Periphery and Arctic Programme 2021 - 2027. The two other project partners are LUMA Center Finland (PP2) and University of Galway (PP3). Authors as listed here: Bridget Burger and Huld Hafliðadóttir (STEM Húsavík), Oona M. Kiviluoto (LUMA Center Finland) and Dr. Jessamyn Fairfield and Dr. Claire Murray (University of Galway).

Arctic Communities

Uniqueness, Heritage and the Possible Futures

> *The future of the Arctic will be determined by the choices youth make and their priorities in terms of culture and identities, where to study and where to live, and what occupations and lifestyles to pursue, as well as their choices concerning factors that affect the environment, and the impacts and adaptation to climate change.*
>
> *-Arctic Youth and Sustainable Futures*

To be able to support youth in making choices for the future, the community needs to come together for a shared cause, that is, the future of each community.

Communities in the Northern Periphery and Arctic region share a unique connection to the natural world, even as it changes, as well as cultures developed at the edges of the world. The heritage of these places includes a deep understanding of nature, scientific and technical ways of living in marginal environments, and traditions that bring people together such as storytelling and sharing of resources. Empowering increased agency for these communities in the spaces of science, technology, engineering and mathematics could result in increased economic opportunities, improved environmental literacy and access to knowledge resources, and stronger interconnection with communities facing similar challenges.

The geographic isolation of these communities shapes them in many ways, both as a unique advantage and as a challenge. Isolation drives the strong connection with nature, but also presents obstacles for shared economic and educational resources that are more prevalent in more densely populated areas. This can also drive a talent drain, where locals are forced to leave peripheral areas to pursue educational and other opportunities, and then must make the choice to return. As the global economy changes, becoming in many ways more interconnected by the possibilities of remote work and continually improving modes of transportation, these communities may be able to adapt and find new relevance on the global stage.

For example, climate change poses a crucial challenge in these regions, especially given their proximity to rising sea levels, glacial and ice caps melting, intensifying weather patterns and other effects. There are additional impacts from geopolitical instability in the Arctic which can be difficult to predict but must be a part of any future planning.

The NPA Region

The Interreg Northern Periphery and Arctic 2021-2027 Programme is an EU funding programme supporting cooperation between remote and sparsely populated communities in the northernmost part of Europe, combining Interreg resources and skills to get the best results for Arctic communities. The Programme forms a cooperation between 7 programme partner countries; the Member States of Finland, Ireland and Sweden in cooperation with the Faroe Islands, Iceland, Greenland and Norway. This large programme area shares several common features, such as low population density, low accessibility, low economic diversity, abundant natural resources, and high impact of climate change. This unique combination of features results in joint challenges and joint opportunities that can best be overcome and realised by transnational cooperation.

The specific regions targeted in each country are shown in the map below:

Figure 1: Map of NPA Region

While these regions are different in terms of latitude and longitude, they share an identity which is formed by living at the northernmost edges of Europe, in rural and remote places, and in ecosystems which will be affected soonest by climate change.

The Need

The Arctic regions face harsh weather conditions, including long, dark winters with cold temperatures. The unpredictability of weather, from sudden storms to temperature fluctuations, presents significant challenges for infrastructure, transportation, and daily life.

Climate change disproportionately affects arctic indigenous communities, whose livelihoods and cultures are closely tied to the land and sea. At the same time, an increasing number of field studies demonstrate significant adaptive capacity (Ford, J. D., McDowell, G., & Pearce, T., 2015). For projects

involving STEM Ecosystems, it's important to integrate Indigenous knowledge and practices to create more holistic and resilient solutions.

The issue of economic workforce and youth drain is current in all arctic and rural regions due to the migration of highly educated young people seeking better job opportunities and higher salaries elsewhere. In Iceland, for instance, the high percentage of women aged 20 to 39, move away from their rural hometowns, for higher education and less than half of them return home (Anna K. Gunnarsdóttir, 2009). The limited local job market and the challenges of geographic isolation often compel young people to relocate to larger urban centres where career prospects and economic stability are more accessible. This talent loss significantly weakens local economies and communities, particularly in the STEM sectors, where skilled professionals are in high demand but difficult to retain.

> “To me, this is no less a matter of rural development than of building the skills needed for the future. We have to ask ourselves what will be the jobs in the rural areas in 10 years or 20 years? And **who** will decide? We must provide a fertile ground that will support our children in building skills and confidence, so that they can create the jobs of the future.”
>
> -Huld Hafliðadóttir, STEM Húsavík Co-Founder

Figure 2: Quote 1/5

Building robust local STEM ecosystems can create career pathways, particularly for girls and women in STEM, who play a vital role in communities. Investing in education, local workforce development, and sustainable economic projects is essential to keeping arctic communities vibrant, economically viable, and attractive places to live and work. In times when we do not know how the jobs of the future will look, local youth need to be empowered to build skills as well as taught to imagine their dream job. After that STEM communities can help to fulfil these dreams.

Making STEM a part of the way we live is essential at all stages of life. However, the greatest impact can often be found by focusing on educational contexts such as primary, secondary, and third-level institutions of learning. Students in these contexts are open to new ways of thinking, and frequently act as scientists (following the scientific method) without necessarily naming it as such. They are keen to understand the world around them, and often make enthusiastic co-design partners asking incisive questions like “What do we not know?” (Aksela & Tolppanen, 2022)

Picture 1: Child playing with sticks

However, it is important to consider the specific challenges that schools face when designing programmes for implementation in formal education contexts. While teachers generally welcome new resources and approaches, they are under intense time pressure to ensure that the full curriculum is delivered to their students. This means that they cannot necessarily support troubleshooting of new teaching materials, and any program introduced must have a strong alignment to existing curriculum. They may also be constrained by requirements to tie in with material taught at different grade levels, and at secondary and third level there may be a need to present career path information as well as taught content.

Students and teachers are incredible partners for STEM ecosystems, but their needs must be centred when developing material for these contexts. This does not mean that material beyond the curriculum should be avoided or ignored, but instead it should be acknowledged by practitioners that interweaving connections to the curriculum may support teachers to make space and time for different types of STEM or STEAM content, or that it might be necessary to explore this type of material in informal contexts.

The ecosystem's approach offers a complete bottom-up approach, which means that teachers are involved from the start and their needs act as a crucial navigation tool in the process. A broad cross-sectoral support for teachers who want to implement STEM into the classroom is one of many advantages of the ecosystem's approach. In addition to teachers and the formal classroom setting, research supports that what happens outside the classroom has significant bearing on students' success in the classroom. Involving parents as a vital part of the STEM ecosystems model is crucial.

A study on educational intervention designed to promote interactions between children and parents relating to maths, showed that talking to children about numbers, playing board games, and even one's own personal maths anxiety can have a significant impact on children's maths performance in school (Berkowitz et al. 2015).

The evaluation of STEM and STEAM projects is a topic of increasing importance, with both practitioners and funders recognising the importance of critically understanding what was achieved, who was reached and whether it was effective (Volk & Schäfer, 2024). These practices should not only be done with participants as self-reflection with practitioners is also essential to ensure we obtain a more holistic picture of impact and outcomes. To achieve this, mixed methods including both qualitative and quantitative approaches can be used before, during and/or after events/activities, with increasing numbers of peer-reviewed publications sharing STEM or STEAM evaluation.

An important framing for STEM and STEAM engagement in NPA communities is formal, informal and non-formal contexts. Formal STEM engagement occurs within classroom environments as part of the

curriculum (Lewenstein, 2015). Non-formal learning is defined by UNESCO as "*organized and sustained educational activities that do not correspond exactly to the definition of formal education [and] may or may not confer certification*" (UNESCO, 2003). Informal STEM learning is a much broader domain that encompasses all other educational opportunities (Morris et al., 2019). This could be in a museum/science centre, in an after-school club, in a theatre or at home.

Forming a STEM Learning Ecosystem

Figure 3: Combined SLE and TIES logos

What is the STEM Learning Ecosystem approach?

The STEM Learning Ecosystems movement began just over a decade ago in the United States, led by TIES: Teaching Institute for Excellence in STEM, an organisation dedicated to building the STEM talent pipeline and expanding the community-based STEM Learning Ecosystems model worldwide.

The STEM Learning Ecosystems approach brings together diverse stakeholders to advance the STEM talent pipeline in a region, state, or community. Using evidence-based practices and grounded in research, the model brings together partners across different sectors, such as education, industry, government, arts, families, community groups, research institutions, and cultural centres to work together to identify opportunities and forge actionable solutions. It is therefore known as a "cross-sector" approach to building partnerships for STEM education.

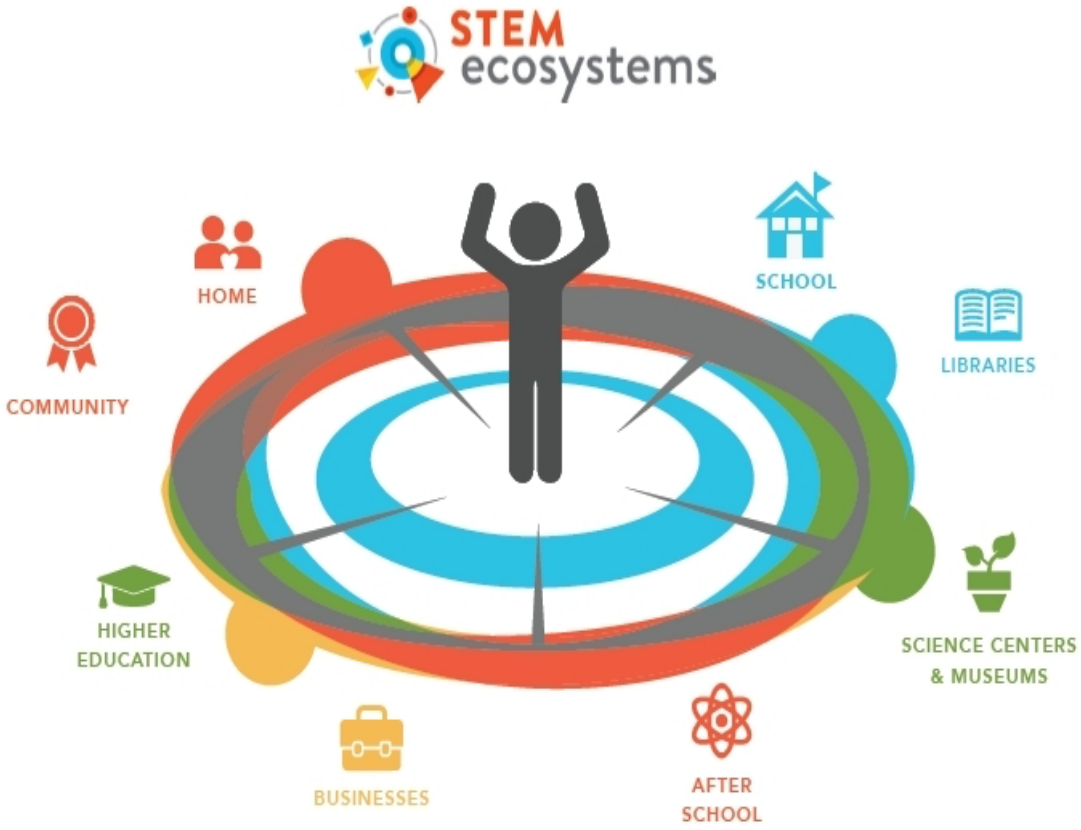


Figure 4: STEM Learning Ecosystems Model

A STEM Learning Ecosystem encompasses schools, community education offerings such as after-school and summer programs, science centres and museums, and informal experiences at home. The implicit goal of a STEM Learning Ecosystem is to offer rich, diverse, and meaningful learning opportunities for young people.

STEM Learning Ecosystems go beyond a network, or mere collaboration. The work of forming a STEM Learning Ecosystem generates a shared vision and shared responsibility. Working together across sectors, the stakeholders join forces in a common effort to benefit STEM education in the community at large. Whether a community is focused on STEM education, or a subset of this such as improving

outcomes for girls and women, this model can be a useful approach to building capacity for positive change.

Building a STEM Learning Ecosystem in any Community

The role of the Community Champion

Figure 5: The Champion of the SLE model

Forming a STEM Learning Ecosystem is a participatory and strategic process. It should begin with a core group of one or two individuals committed to seeing the process through from the start. We call these individuals the "Ecosystem Champion", and every successful STEM Learning Ecosystem has a dedicated Champion to launch and manage the SLE efforts. It is ideally part of their paid position to undertake launching an SLE, in an institution which supports these efforts, by dedicating in-kind or cash contributions for staff time, meeting space, advertising and promotion, fundraising support, and hospitality.

> "Basically, it's just someone who has the ability to connect different people to different sectors, and bring them to the table and hold it together. That's what's needed. So if it turns out to be a principal, that's great, if it turns out to be a parent, that's great too. What we call that person is the champion. We need a community champion."
>
> -Bridget Burger, STEM Húsavík Co-Founder

Figure 6: Quote 2/5

The STEM Learning Ecosystem should be inclusive and open to any stakeholder who wishes to support the efforts. Toward this end, inclusivity and accessibility is a key consideration. Having meetings in a

central location, for example in a public space and easily accessible by public transportation, and held after working hours, can help to ensure that all sectors of your community are represented. The chart and description below will help you ensure that all stakeholders are represented.

Identifying the Stakeholders

You may already have relationships with many stakeholders through your existing organisation´s work. The STEM Learning Ecosystem gives you an opportunity to strengthen these bonds and focus efforts for the benefit of your community in a specific way. Through this process, new, unexpected relationships can be formed and old ones strengthened anew as you take a fresh look at your community through the lens of STEM education.

> “STEM Húsavík is like this giant magnifier, shedding a light on the scientific process that the children and the teachers are already doing and just making people aware of it.”
>
> -Teacher at Grænuvellir Kindergarten

Figure 7: Quote 3/5

Forming an Advisory Board

The process begins by forming an Advisory Board. This Board has the specific goal of launching the ecosystem and seeing it through its first year of success. It is first a matter of identifying who might be a possible member. In the Arctic STEM Communities project, we used this template to identify who might be potential Advisory Board members. The goal was to have at least one person representing each sector.

Begin by brainstorming using the chart provided on the next page. Identify 1-3 potential individuals you know from each category by listing their names in the spaces provided. Brainstorm with your core group or colleagues and discuss the merits of your proposed members. Trust and engagement are two big factors to consider. You will need to trust the Advisory Board members and be able to lean on them for your support in the first year, so their availability and engagement will be critical.

Some things to keep in mind are:

- Availability of the individual
    - Are they already committed to many projects? If you think they may be overcommitted, or just "too busy", you may still reach out to them to ask them to nominate someone they know.
- Experience within their sector
    - Look for individuals who have years of experience within their sector. They will bring keen insights to your project. They also can leverage strong networks within their sector to begin further engagement to the ecosystem activities.
- Look for activities that align with STEM
    - Your Advisory Board members should have some direct role in science, technology, engineering or math activities, whether in the field or in STEM education.
- Representation of the members
    - Your Advisory Board should represent your community and be as diverse as possible. More perspectives and background, points of view and experiences will aid your board to bring a rich tapestry of ideas to the table when they meet.
- The synergy between the members
    - Your advisory board ultimately must work together harmoniously for the benefit of all. Self-interested individuals will not last long. Try to select, among those potential members you identify below, the ones who will work most collaboratively together.

Table 1. Identifying potential Advisory Board Members: Fill in up to three individuals per sector.

Name	Sector	Organisation	Email/phone	Contacted?
	Higher Education			
	Compulsory Education (K-12)			
	Science Centers & Museums			
	Industry			
	Government			
	Afterschool STEM programs			
	Families			
	Libraries			
	Research Institutions			

The Champion (with support from their core group) should rank their first, second and third choices of individuals to form the Board, and then begin to outreach to the first choices in each sector, inviting them to have a brief discussion about the project and why they are chosen to participate. Upon receiving a positive response, the Champion can then send them a formal letter of invitation.

You may decide to invite more than one person from a sector, for a variety of reasons. If you decide to invite more than one (from different Kindergarten to elementary grade bands for example) try to incorporate different regions or school districts to also have geographic representation. Similarly, with industry, you may choose to invite two different industry representatives, but it is recommended they be from different industries. Keep in mind that the ideal board size will be 10-12 individuals, with at least one person representing each sector.

When you either do not receive a response, or your invitee declines to participate, you should go on to the next person you identified in that sector. If you haven´t found someone after you have exhausted your three choices, brainstorm again, perhaps asking those who have accepted the invitation to help you identify others. It is critical to have at least one person from each sector represented in the launch of your SLE, if possible. You will need a full day to launch your SLE– either one full day or two half days close in proximity to each other. You can either choose the day(s) in advance for sending the invite or wait until members are confirmed to join the board and then send a group poll (such as Doodle).

The official invite to launch the SLE should go out to the members, along with an electronic calendar invite including the location and any special parking instructions, and pre-work documents at least three weeks before the event. A sample email can be found in Appendix A. Pre-work documents can be found in Appendix B.

Convening the Advisory Board

The process of forming the SLE is a structured process that requires full participation from your board, from the moment you send the invite. The Pre-Work asks your board members to reflect upon the situation in your community with respect to STEM education, what they value and what they perceive. It begins the process of forming a vision for the shared community. It will save a lot of time if board members can complete this thoughtfully in the weeks before the launch event. It is recommended to send a reminder email one week before the launch day (with a reminder to complete the pre-work documents, attached again to the email).

Launching the STEM Learning Ecosystem

In the communities participating in the NPA Arctic STEM Communities project, we used the following process to define and launch the three STEM Learning Ecosystems and their pilot project. We describe each one of these below, with suggested time allocations, and provide agendas in Appendix C. You can tailor your agenda and activities to your specific community. A sample slide deck used as a visual aid at one of the workshops is provided in Appendix D.

I. Introductions and the SLE model (30 mins)

A. We began each session by introducing each person with a one-minute time limit, as a form of an icebreaker. There are many examples of these types of activities, and you can select the one that makes sense for your group.

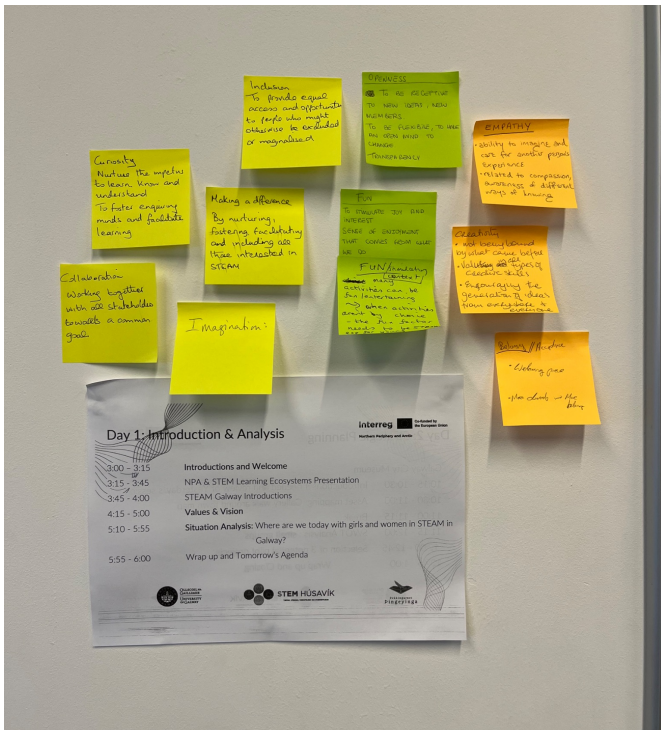
B. Then the Champion introduced themselves, their role, and their inspiration for launching the SLE.

C. Finally, the SLE model was introduced, including its history, benefits, SLE Community of Practice, and showing visually how each sector is represented, and examples from other SLEs how they work together to achieve their goals.

Picture 2: Introducing SLE model, Galway 2024

II. Values/Vision (45 mins)

The Values are the core beliefs that drive your actions. In our process, we did not have to agree on the values. One person´s value was included in the group´s values. We asked members to break into groups of two with someone they preferably did not know or work with, to help "break the ice". We then used a brainstorming method with sticky notes to populate a space on the wall or a large poster board where the groups of two could write and post their values.



Picture 3: The process of finding values, Galway 2024

As facilitators, we observed when a value was identical, and grouped them to save space. At the end of the allotted time, we read out the values that had been posted. When any values overlapped, we asked the full group to discuss whether this was a duplicate value or whether one term was more accurate or useful than another. For example, "caring" and "kindness" …are they the same or different? Do we choose to have them both?

This process is a valuable one, and the conversation around values begins to form the bond that shapes the identity of the SLE.

Picture 4: Conversations around values, Galway 2024

Vision Statement

The vision statement is aspirational: *Where does this organisation want to be in 30 years?* And can be focused: *What is it that this SLE will offer over the next two decades that represents the mission accomplished for girls and women in STEM?* Ask: *What is the big bold vision we hold for girls and women in STE(A)M based on these values?* The vision statement is ideal and lofty. It incorporates the values that you have just identified.

Using the pre-work documents as reflections, we break the group into small groups of 3 to work for 15-25 minutes on a vision. It should be a clear succinct vision statement people can remember. From the small group vision statements, the Champion facilitates a discussion of the full group

shaping a vision statement using core ideas from each small group statement. (See Appendix E for examples of vision statements).

Picture 5: The process of creating a vision statement, Rovaniemi 2024

III. Situation Analysis (30 mins)

The situation analysis aims to identify where the community is currently concerning a specific topic. This can be STEM or STEAM education in general, it can be specific and topical to girls and women or traditionally under-represented groups. Regardless of the topic, it should be grounded in data. The Champion should prepare a slide deck featuring data collected around the topic and from a variety of perspectives. The data should be disaggregated wherever possible. For example, gender-based university attrition rates, STEM degree program attainment, and high school graduation rates by region are all good metrics for looking at equality in STEM higher education. Career placements, pay

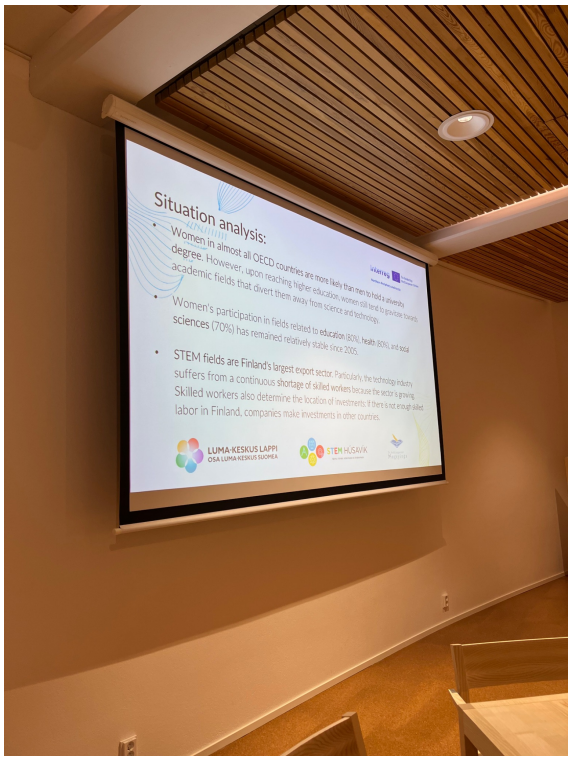
comparisons, and leadership roles within STEM career placements, again by specific regions, are good metrics for examining the current situation in a community regarding STEM employment.

After the presentation, the group should then again break into small groups of 2-3 and begin to summarise the situation in the top three statements, based on what they have heard, and also add in any other data they are aware of. The Champion may also provide a website for further exploration at this time.

The Champion should bring the entire group together to summarise statements and facilitate discussion and agreement on the situation in the community concerning the focus area. The Champion then facilitates agreement on the top three statements from all the group statements. These three statements become the Current Situation.

The question then becomes: *How do we get from the Current Situation to the Vision Statement?*

The Champion facilitates a discussion of early brainstorming– ideas are put on a board or screen as a placeholder until further analysis is done.



Picture 6: Situation analysis

IV. Asset Mapping Exercise (30 mins)

Picture 7: Assett mapping exercise

The Asset Mapping exercise can be a fun way for the newly formed partners to work together. You will need a table and a large piece of paper with hand-drawn or printed maps, pens, and sticky notes. Board members add the names of individuals and stakeholders who they think would be a good addition to the SLE. Ask: *Who in our community is a resource for the issues we have identified, and the vision we have formed?*

Board members can add names, and this is an enjoyable activity that gets people out of their seats. It can be done during a coffee break, lunch break, or as its activity if there is time.

V. SWOT Analysis (45 mins)

The SWOT analysis is given out as pre-work. Board members are asked to complete this prior to attending the launch meeting. In our experience, not everyone will do this. Having the information prior to the meeting saves a lot of time, and while board members are at lunch, or in a break period, the Champion or assistant can begin to populate a large whiteboard with answers from members, avoiding any duplication.

If not all the members have completed the SWOT analysis as pre-work, then hand back the papers to those who have completed it and have the full group break into small groups of 2-3 and work together

to complete a SWOT analysis sheet. They will need guidance in completing the sheet. Have them complete the compiling of the analysis in this order:

Strengths

These are elements internal/from within the current and planned SLE.

What does the SLE possess that will be an asset in the planned efforts?

Weaknesses

These are elements internal/from within the current and planned SLE.

What needs to be strengthened?

Threats

These are negative elements external to the organisation.

Some examples are: lack of funding, inflation and rising rent, political instability.

Opportunities

This is the area for the SLE to focus on: *What opportunities will the SLE decide to take on?*

The SWOT analysis is meant to be a collective analysis that results in an action plan. Doing the analysis in this order strengths-weaknesses-threats-opportunities allows for this to happen.

VI. Additional: Creating a Mission Statement

In addition to the Vision Statement, the Ecosystem Advisory Board and Champion might want to create a Mission Statement, concentrating and summarising the mission of the newly formed initiative/organisation to help respond to change and make decisions that align with its vision.

VII. Choosing a Pilot Project (30 mins)

From the Opportunities list, the Champion can then facilitate a discussion about prioritising the actions on the list. In our case of the Arctic STEM Communities project, each ecosystem's Champion (and lead of the NPA project) planned a separate meeting with their ecosystem's advisory board as a follow-up, around two weeks after the launch, to discuss the turning of the actions into possible pilot projects. Pilot projects can be chosen based on available resources, including human resources, or on other criteria identified by the advisory board.

The advisory board then decided on the top three possible pilot projects and in a joint Teams meeting of the NPA project partners, each Champion presented the three possible projects to each other. The project partners then used a specific metric provided by the STEM Specialist to help each other choose a pilot project, see Appendix 3. The pilot project chosen for each ecosystem in the NPA project will be better outlined in chapters on the pilot projects.

Co-design Approach

Through the participatory process by which a STEM Learning Ecosystem is co-designed by the stakeholders themselves, the stakeholders begin to form strong partnerships and identify as a community-based entity. Together, they identify the goals of the SLE, which will vary according to the needs of each community.

That means that each STEM Learning Ecosystem is unique- no two are alike. They are built from the ground up by the community and therefore are responsive to the needs and capacity of the community to empower itself. By building partnerships across sectors, partners build lasting relationships that take on a life of their own.

Sustaining Your Ecosystem

Financial stability is a critical factor in the success of any STEM Learning Ecosystem. Securing funding is time-consuming and can be emotionally draining for the Champion to constantly seek new funding sources to sustain the efforts. Some SLEs are part of a regional, state, or national STEM education effort. Making sure that projected budgets and financial needs are made clear to the funding authorities well in advance of budgetary allocation cycles should be a top priority.

Securing funding for the partnerships and ecosystems is a persistent challenge that requires dedication, strategy, and resilience. The ecosystems, like other not-for-profit organisations, must often rely on grants, donations, and sponsorships, which can be inconsistent and competitive, not to mention that sponsorship and philanthropic gestures vary greatly between cultures.

If funding is not secure for your organisation, build into the launch process a fundraising strategy. Tap into the expertise of the members who come from philanthropic or nonprofit backgrounds. Your group may decide to form a special committee just to address the funding challenges.

Benefits of the STEM Learning Ecosystem Approach

Robust STEM Learning Ecosystems have the potential to drive changes at the community level, by identifying needs and assets located in that community, identified by that community. Below are just a few of the known benefits of a STEM Learning Ecosystem responding to the needs in a community.

By focusing cross-sector partnerships focused on STEM education at the community level, STEM Learning Ecosystems have the potential to:

- Cultivate high levels of interest and motivation that can play a significant role in building STEM skills and career aspirations (Maltese & Tai, 2011, Traphagen & Traill, 2015)
- Strengthen partnerships between many community sectors to create a network that provides more educational and workforce opportunities and pathways into STEM (Allen, Lewis-Warner, & Noam, 2020)

- Revitalize the approach to STEM learning in and out of the school setting by providing diverse STEM learning opportunities (Traphagen & Traill, 2014)
- Generally: Establish a skilled workforce and support global competitiveness.
    - STEM careers are linked to the social and economic mobility of individuals, families, and communities, and having a skilled STEM workforce supports international global competitiveness (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007)

LUMA Centre Finland - Background

LUMA Centre Finland

The word "LUMA" represents STEM (Science, Technology, Engineering, Mathematics) in Finnish, but it carries a distinct meaning compared to its common use in teaching-related literature globally. While STEM and STEAM pedagogies emphasise integrated education in these subjects, in Finland, it has been an intentional choice to use the term LUMA, tailored to the Finnish educational context. The pedagogical models that LUMA Centre Finland develops strongly recommend an integrated approach but many teachers in the network value also the discipline-specific materials.

LUMA Centre Finland is a nationwide network, with 13 regional so-called LUMA Centres, that promotes science, maths, and technology education at all levels. Built inside of 11 Finnish universities, it collaborates with schools, and educators to inspire interest in these fields through research-based activities, events, and teacher training.

LUMA Centre Lapland: Bringing LUMA directly into primary schools, virtually by shortening distances

Figure 8: Finland map and flag

The northernmost LUMA Centre in Finland is situated in Rovaniemi, within the Faculty of Education at the University of Lapland. The operations of LUMA Centre Lapland are integrated into the primary school teacher education program at the Faculty of Education. As part of the teacher students' studies, all first-year students participate in LUMA activities through a science education course, where they lead workshops for children. Additionally, a course titled "LUMA Clubs" which is worth three credits. These credits are earned by facilitating various LUMA activities and reflecting on the experiences gained during the process. The primary focus is on engaging primary school teacher students and supporting primary school teachers in facilitating inquiry-based learning in physics, chemistry,

mathematics, and programming. For this, the Centre has developed educational materials for all these subjects.

The STEM Learning Ecosystem

LUMA Centre Lapland already maintained a close partnership with the Arctic Centre, which conducts diverse research on the Arctic region. The Arctic Centre's science exhibition at Arktikum provides a platform for a wide range of LUMA activities. LUMA Centre Lapland also collaborates extensively with the other three faculties at the University of Lapland: Art and Design, Social Sciences, and Law, as well as with the Lapland University of Applied Sciences.

The new STEM learning ecosystem was formed in Rovaniemi. It took the name LUMA forum that better described the action in the Finnish context. LUMA forum was formed around ongoing and new collaboration to support local Lappish LUMA activities. The new STEM ecosystem vision statement stated the following:

> “All people, regardless of background, have access to and awareness of LUMA and how they can use it in their everyday lives. LUMA is offered systematically, in and out of schools, to build skills and create pathways to careers that benefit society.”

Figure 9: Quote 4/6

LUMA Pilot Project

Given the vast distances across Lapland, it is not feasible to reach all schools and students through in-person visits. Therefore, LUMA Centre Lapland already had created virtual inquiry-based activities

through our online science lab and by offering video-based in-service training for teachers. In the Rovaniemi meeting, the STEM Learning Ecosystem presented three pilot project ideas.

1. An event that engages the local industry and focuses on girls & women in STEM.
2. Digital Network: Identifying local needs for STEM teaching materials and creating a collection of digital fun learning materials.
3. Fun STEM digitally delivered activities for after-school programs.

The pilot project was aligned with the newly drafted vision and took the form of an after-school online science club (option 3.). The project was chosen because it was something new for the ecosystem and the whole of Finland. The club was accessible to children living in Lapland's most remote areas. Other regional LUMA Centres were invited to create material so that the workload was distributed. All 21 municipalities in Lapland were invited through email and hundreds of children could join in hands-on STEM activities.

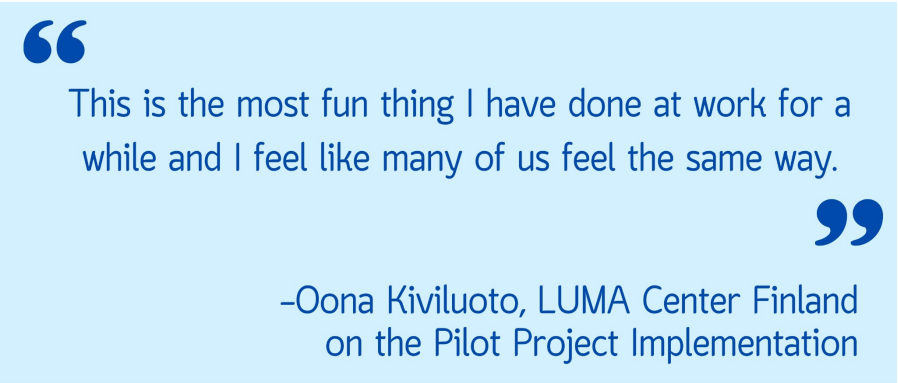


Figure 10: Quote 5/6

The club was held every Tuesday for one hour in the afternoon for two months. The participants could choose from the club program the club sessions that they want to take part in or take part in only the bilingual club sessions (Finnish and Swedish). All the materials and links are on the same website. All the club's activities were designed so that they require only the usual inexpensive everyday materials that are common in schools or that can be easily obtained from grocery stores.

Feedback was collected after the online club from the after-school teachers who were occasionally also preschool teachers, childcare assistants, and even parents. Participating adults felt that the format was working very well and the webpage with videos was liked. The majority of the feedback was positive, and the STEM activities were considered fun and age appropriate. The negative feedback was mostly about the one-hour duration of the club which was considered too long. The best activities were the ones where the instructions were given at the beginning of the club in 5-10 minutes and the children were given the most time to hands-on work. This model would need even fewer resources if the club were organized in the future.

Galway STEAM Learning Community - Background

Figure 11: Ireland map & flag

The city of Galway originates from the mediaeval period and is situated on Galway Bay on the west coast of Ireland. The region has a strong history of storytelling, music, and performance, which is reflected in the many festivals and events that span the calendar in Galway city. This reflects the broader context of Ireland, which boasts one Nobel Prize in the sciences and four in literature. This cultural heritage is the reason for taking a STEAM approach, where STEM is combined with the arts to reach broader audiences and tie in to existing artistic practices.

Dr. Mairéad Hurley and Dr. Liz Coleman founded the Galway STEAM Learning Community in 2022 in order to "build capacity for STEAM & Education and Public Engagement in Galway with the goal of placing community participants alongside scientists, artists, policy-makers – broadening potential for

public agency in STEM via two-way dialogue, while always acknowledging socioeconomic pressures and the participants' cultural contexts." The community was initially developed as part of their project Spéirscéalta, which identified that there were many actors practising in the STEAM space in Galway, but without an anchoring group, or connecting web to accelerate partnerships and develop new projects. Initial community meetings brought together STEM professionals, teachers, festival producers, artists, and community organisers to discuss shared dreams and challenges. However, as the initial project was funded on a fixed-term basis, it was unclear how the STEAM Learning Community could be sustained when the practitioners involved were all under immense time pressure with their many projects.

Through the Arctic STEM Communities NPA project, the STEAM Learning Community hosted Bridget Burger and Huld Hafliðadóttir in Galway in 2023 for a two-day strategic planning session. We invited existing members of the community as well as new members from many sectors whose work intersected with STEM and STEAM Learning, discussed the STEM Learning Ecosystem approach and how it could benefit Galway, and constructed an asset map of local people, projects, and resources. In discussing possible projects, the community could undertake with the support of the Arctic STEM Communities project, three were proposed: a school workshop on embodied cognition in physics, a leadership forum for girls and women in STEM, and an evaluation tool for STEAM events which could be shared throughout the community, to support projects without the budget to develop such a tool themselves. After consideration based on project feasibility, engagement, collaboration and impact,

the evaluation tool was selected for the pilot project. We also developed a Galway STEAM Learning Community vision and values, as follows:

> Our community is built on respect, openness, curiosity and empathy. We work together using diverse and creative STEM practices to:
>
> - Foster engaging lifelong learning in and out of the classroom
> - Tackle societal challenges
> - Make a positive difference for all

Figure 13: Galway STEAM Community Vision

Figure 12: Galway STEAM Community's Values

Galway Pilot Project

Evaluation is defined as "to judge or calculate the quality, importance, amount, or value of something" (Cambridge Dictionary Definition), and within a society wanting improved value for its investment in science and arts activities, it plays an increasingly important role in STEAM engagement. However, time pressures and limited staff availability/experience means that many projects are unable to deliver meaningful evaluation of their work. The evaluation toolkit developed as the Galway pilot project was therefore designed to support users to evaluate their events, building on literature and practical experience. We developed a nested evaluation tool that can have three different lengths building on the varied public engagement work by the Galway STEAM learning community, using questions that were trialled as part of the We Built This City on Rock and Coal climate change show, the CÚRAM Superhuman exhibition, and others. The different lengths of evaluation can be delivered as surveys or via interviews as desired. The target users of this toolkit are STEAM practitioners and organisers, particularly those who do not have access to evaluation expertise or time to develop an evaluation strategy in their project.

The development cycle of this evaluation tool was:

1. Invite partners to participate who had evaluation approaches they could share, or upcoming projects where an evaluation tool would be useful.
2. Collect questions and methodologies from existing projects.
3. Reflect, combine, and edit existing material into a nested questionnaire which can have 3, 8, or 15 questions (to be used in writing or as a starting point for interviews).
4. Share draft version of tool with development partners and interested parties for feedback.
5. Invite partners to road test the evaluation tool in their own projects, for example the projects currently running as part of the STEAM Learning Ecologies Horizon project which are keen to use this work. Feedback will again be collected and refinements added to create a final version of the evaluation tool.

6. Share final version of toolkit with broader Galway STEAM Learning Ecosystem, hosting a workshop to talk through potential uses of the questionnaires and how to evaluate the data generated.

The tool at a minimum enables users to monitor how their attendees engaged with their event as well as building a longer-term view of how the events are operating. It has questions which are nested within each other to ensure consistency and enable comparison of all events. The longer version offers the opportunity to understand what audiences are engaging with events, as well as making space for qualitative reflections on broader themes within the events. However, since the longer version requires more work to analyse and explore, users are encouraged to consider their time availability for critically engaging with the data before starting.

The Short, Medium and Long Questionnaires are intended to be nested, and to be delivered in the order provided - i.e. the short questionnaire should always be asked first, then the medium questionnaire, followed finally by the long questionnaire. This structuring will enable subsequent reliable analysis of the data from different events, because a random ordering of questions might change the answers that people would otherwise give. By sticking to the order provided, evaluators have a robust methodology to compare evaluation results across timescales and topics. If evaluators want to move questions around, they should ensure consistency to enable longer term comparisons.

This tool is currently being road-tested by the Galway STEAM Learning Community, and a final version of it will be shared on the Arctic STEM Communities website.

STEM Húsavík - Background

Húsavík, the largest town in the Municipality of Norðurþing, with approximately 2500 inhabitants, is nestled on the northeast coast of Iceland on the shores of Skjálfandi Bay.

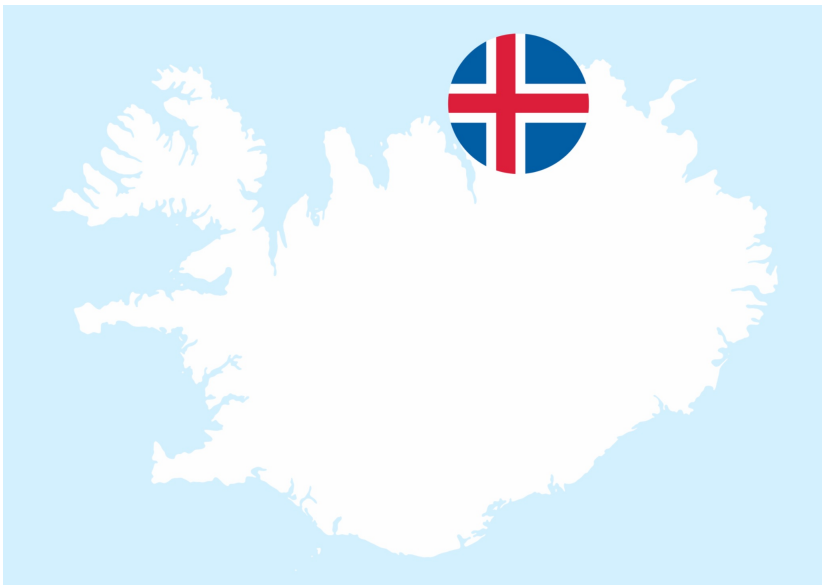


Figure 14: Iceland map and flag

In the late summer of 2021, community leader and project manager Huld Hafliðadóttir became aware of the U.S.-origin STEM Learning Ecosystems model to advance STEM education, as she met Bridget Burger, at the time Director of Cape Cod Regional STEM Network, in Húsavík. Huld immediately saw the potential and need for such a community-based approach to benefit the small community of Húsavík, which, like other arctic communities, faces challenges around globalisation, climate change, demographic changes, workforce development, lack of voice, limited resources, infrastructure, health, environment and community preservation.

The Launch of STEM Húsavík: The First SLE in Iceland

The two started brainstorming about ways to work together and/or eventually bring the ecosystem approach to Iceland. In May 2022 Bridget came as a Fulbright Specialist in STEM education to the Húsavík Academic Center, where Huld was currently employed as a project manager. During the two-week visit, Bridget guided Huld in the process of launching a STEM Learning Ecosystem, leading her through the step-by-step process described in the previous chapter of this manual.

The STEM Húsavík ecosystems advisory board came up with the following mission statement:

> Empowering people and building skills by connecting diverse resources, nature and the community

Figure 15: STEM Húsavík Mission Statement

STEM HÚSAVÍK

TÆKNI, VÍSINDI, VERKFRÆÐI OG STÆRÐFRÆÐI

Figure 15: STEM Húsavík Logo

The board then decided on the three pillars the newly formed ecosystems would act towards, that is: A) To increase awareness about STEM in the community, B) to connect with schools and support teachers, and C) the sustainability of STEM Húsavík.

At the launch of the NPA project, therefore, STEM Húsavík had been operating for a full year. Its initiatives during the first year were, amongst others; launching an out-of-school robotics club for children and nature summer camp for children, offering series of teacher professional development, launching a STEM lending library for teachers and hosting open meetings for the public about STEM in the community. Building on the success and tailwind of the STEM Húsavík pilot project we applied for the NPA project Arctic STEM Communities.

STEM Húsavík's process within the project was to expand the Húsavík SLE as well as choosing and launching a pilot project in relation to girls and women in STEM.

STEM Húsavík Pilot Project

In November 2023, the STEM Húsavík Champion called the advisory board together for a strategic meeting regarding the expansion of the ecosystem and for the process of discussing and choosing the pilot project. Since, during the strategic planning process of the launch of STEM Húsavík in 2022, a vision statement was not formed, only a mission statement, the advisory board worked to form a vision statement for STEM Húsavík during this process.

The meeting's agenda included the following:

- Values and vision statement for girls and women in STEM
- Situation analysis on girls and women in STEM presentation
- Top three situations on girls and women in STEM
- SWOT analysis (small groups & full group)
- Identify three pilot projects (small groups & full group)

Values of STEM Húsavík

The values chosen by the advisory board are the following:

Figure 16: STEM Húsavík Values

The Vision Statement of STEM Húsavík

> We work together in a strong, active and open STEM learning community that breaks down stereotypes and barriers, to create an environment where everyone has equal access and information to opportunities in STEM.
> Furthermore:
> - We have enough STEM specialists
> - We have alignment in the curriculum between the grades as a policy

Figure 17: STEM Húsavík Vision Statement

As described in the previous section about launching the ecosystems in the NPA communities, the process undertaken during the meeting in Húsavík was alike, the advisory board worked together in smaller groups to form a vision statement for girls and women in STEM, which then was collated into one joint Vision Statement.

Then, a situation analysis was presented by the Champion/Ecosystem Lead on girls and women in STEM in the region. The analysis shed, amongst others, light on that stereotypes and attitudes exist in the community that create barriers and lack of confidence to STEM careers and pathways (amongst students, parents, teachers); STEM pathways and careers exist but are not visible or promoted (more role models are needed) and that within the schools current STEM activities are promoted to boys as a non-academic accommodation, which could make it less desirable to girls.

As a result of the SWOT analysis the three possible pilot projects took form and were the following:

1. To connect teachers with companies and STEM professionals in the community.
2. Career awareness event for students, parents and teachers.
3. STEM Council for teachers to share ideas and address situations (i.e. map out STEM education, collect data, offer STEM professional development)

Choosing the Pilot Project

The pilot project was chosen by the Champion after a meeting with and the help from the other NPA project partners using the metric tool provided by the STEM Specialist. Based on feasibility, engagement, collaboration and impact, the proposed project on the **STEM School Council** was chosen. Since STEM and the awareness about STEM in the community is relatively new to the residents of Húsavík, starting within and between the schools, by aligning curricula and advising across different school stages seemed to be the right way to start. The Champion reached out to the administrators of the three schools of Húsavík, Grænuvellir preschool, Borgarhólsskóli elementary school and FSH upper secondary school.

Outcomes

Data was collected over the course of this project in a variety of ways. Surveys were used for pre-, during, and post-project implementation. Qualitative discussions were held individually with each Champion leading each STEM Learning Ecosystem in regular check-ins. Focus group interviews were conducted with the Champions of each NPA STEM Learning Ecosystem. Finally, a validated measurement instrument, developed by TIES in collaboration with the SLE CoP called Caliper, was conducted toward the end of the project to assess the success of the new or newly expanded STEM Learning Ecosystems. A discussion of the data collected, and a summary of the results follows.

Through surveys, interviews, and focus groups, data was collected that informed the issues and barriers that arise during the process of launching the STEM Learning Ecosystems and the NPA pilot projects. Several common themes emerged from the qualitative analysis of this data.

Barriers and Challenges

The groups identified several common challenges that they faced in various stages of forming their STEM Learning Ecosystem. These challenges mostly revolved around the human and cultural factors involved with forming an ecosystem in a community.

Community Engagement

The project partners mentioned a **lack of existing community engagement or integration** as a primary challenge they faced when launching the SLE model. Furthermore, there was a **lack of collaboration culture** that made it difficult to get buy-in for the cross-sector model. In several instances, there was a **lack of understanding of the model** itself, and new ecosystem members had to reiterate to their fellow community members in different and novel ways to gain their understanding and buy-in for the project.

Finding common ground was a general challenge that all ecosystem members found as they began to establish their hubs. Once the members became willing and agreed to collaborate, it became a question of, "What now? What can we do together?". This arose from different organizations having diverse mission statements, often seemingly unrelated. Through the process of shared visioning described above, they did find common ground as they examined the specific situation with respect to girls and women in STEM in their communities.

Logistics

Another type of challenge that presented itself during the launching of ecosystems was pragmatic and logistical: **finding a time to meet** when it worked for everybody became difficult at times. In addition, finding a common meeting space to accommodate the larger group meetings was sometimes an issue.

Limited Resources

The third type of challenge that arose in forming the ecosystems involved the lack of resources. Members cited the **limited human resources** that impacted their ability to form an ecosystem. As part of the data collection, participants in the launching/strategic planning process were asked to fill in a follow-up surveys few weeks after their meetings. It turned out to be a challenge to have the

surveys filled out, whereas people have limited time and must weigh and prioritise their time and effort. To meet those challenges, offering the surveys as *exit tickets* would be optimal.

Creating an SLE takes dedicated staff time to coordinate, schedule meetings, plan, and follow up. The human resources factor is one that can put pressure on the existing staff to take on extra work.

The NPA project partners mentioned **limited financial resources** and especially **lack of financial support from the government** as inhibiting factors in the growth of their organisations and projects. Funding is often received from grant sources, and continuously identifying and **writing grants can lead to burnout** and turnover in staff.

Finally, another barrier to implementation was the **lack of disaggregated data surrounding girls and women in STEM**. In two communities, gender equality data is not being collected at all in the rural communities involved.

Resources and opportunities

Responses to the surveys and interviews indicated that there were substantial benefits and opportunities that came from the Arctic STEM Communities project, with the result of empowering communities for positive change.

Empowering Communities for Positive Change

The Arctic STEM Communities project partners indicated that because of the project, the communities had an **opportunity to develop shared values and interests**. In addition, the project **enabled more collaboration** and **provided opportunities that came from being connected** in that collaboration.

The partners indicated that the STEM Learning Ecosystem approach **provided vital continuity over time** that supported their work, even though partners within the ecosystem may change. There was **greater communication among the partners** once the ecosystem was formed. The STEM Learning Ecosystem approach also had the effect of **amplifying impact through shared efforts and resources**.

In all, the NPA Arctic STEM Communities initiative **enabled them to be able to take on important projects relating to girls and women in STEM that they could not do alone.** Furthermore, one partner indicated the initiative **enabled them to take on visionary projects around girls and women in STEM**, while another indicated it **enabled them to take on groundbreaking projects around girls and women in STEM that have never been done before.**

These are clearly strong supports for the work that organisations endeavour to do at the community level. The STEM Learning Ecosystem approach and the NPA Arctic STEM Communities project provide a path forward for organisations and individuals aiming to achieve positive change in their communities.

Best practices

What We Found

In our experience throughout the process of establishing the STEM Learning Ecosystems in each community and implementing the pilot projects, we found that the following factors were critical to success:

Engaging the Community

The **engagement of the local community is crucial**, but how do you engage people with different backgrounds to co-design[1] and see the win-win and value for them?

In Arctic rural areas, **online participation should be considered** a viable alternative for engagement. For many communities, traveling after a work or school day is not feasible due to the vast distances involved. If resources are not available to bring activities directly to the people, remote connectivity offers an excellent opportunity to connect individuals and groups in a resource-efficient way. Virtual

[1] https://journals.helsinki.fi/lumat/article/view/1246

solutions can bridge geographical challenges, ensuring inclusivity and accessibility without the need for extensive travel, ultimately fostering collaboration and participation across dispersed communities.

Creating Trust

Partners engage when they feel listened to and valued. This means **including communities in the project design phase, centring their concerns and needs**, and adapting the projects to address these. Even seemingly small factors like **the location of project meetings** and the methods of communication used can build trust with partners before any 'formal' project activity has taken place. In smaller communities, meeting potential partners face-to-face in the run-up to events might help to engage them, whereas in bigger or more sparsely populated areas, a phone call will do the trick. Most importantly, it is critical to meet communities where they are.

Engaging with Local Heritage and Culture

The best way to engage communities with STEM and STEAM education will depend on the **local traditions, heritage, and culture of each community**. There is no one-size-fits-all approach, even in regions sharing many of the same challenges.

> "The characteristics, traditions, heritage of the locality of planned engagements should be considered in workshop development, ensuring to relate the scientific topic being explored to the lives, values, dispositions of the workshop participants."
>
> – Dr. Mairéad Hurley and Dr. Liz Coleman
> Galway STEAM Learning Community

Figure 18: Quote 6/6

Having a Specific Focus

As mentioned above from the data analysis findings, having a **specific focus for activities** can bring diverse partners together in the spirit of collaboration. For our communities, this was women and girls in STEM, but what topics spur people to action can vary from place to place, and sector to sector. The focus can therefore be *to advance STEM education in the region*, as well as *to increase opportunities for youth to engage in STEM activities*.

Considering Your Audience

Communicating STEM topics is most impactful when the **format is optimized for different target audiences**. It is important to do this **research in advance** and use the platform and language that is most appropriate for each audience, on a timetable that suits them. Reaching out to partners in industry, policy, education, or young people would each necessitate different strategies, and ethical considerations should be paramount when asking these groups to participate.

Finding Funding

The work of finding and securing funding is both immediate and ongoing. The ecosystem's Champion must constantly **seek out new opportunities and new funding sources to sustain the effort**. One way to address this immediate challenge of funding and prevention of the drainage of the Champion, is to weave it into the strategic planning process of launching an ecosystem. Ask members from your advisory board to dedicate time and effort to help and support the champion find and secure funding. Keep it time-bound for better progress, structure and a sense of urgency. Here, like elsewhere in the work of the ecosystems, collaboration is key.

Collaboration is Key

Gather collaboration to **share the workload**. When each individual contributes a small, **clearly defined effort toward a shared goal**, participation feels more manageable compared to engaging in prolonged, abstract planning or development processes. People are more motivated to participate

when they can see the clear beginning and end points of their contribution, as it helps them understand what is expected of them and ensures their efforts are tangible and impactful. While collaboration requires deliberate and effective coordination, it can result in large-scale, impactful outcomes when done successfully.

Sustaining the Ecosystem

Sustaining the ecosystems requires **consistent effort, mutual respect, and strategic planning**. Here are some best practices to help you maintain and grow a strong, healthy ecosystem:

Support Within the Ecosystem

Sustaining the efforts requires fostering a culture of care, mutual respect and support. Women, often natural nurturers and connectors in communities, in many cases play a significant role in the maintenance of networks. By focusing on the following areas, an ecosystem can build a strong foundation of trust, collaboration, and shared purpose, ensuring its long-term sustainability. We recommend:

- Checking in on members and ensuring they feel heard and valued.
- Organizing mentoring or peer-support programs to build confidence and share knowledge.
- Celebrating personal and professional milestones to create a sense of belonging.
- Encouraging a collaborative spirit rather than competition.

Work With Who “Gets It”

Identify and focus on members or stakeholders who are aligned with the ecosystem's mission and values. These individuals can be your champions:

- Engage them to drive key initiatives and serve as role models.
- Leverage their expertise to build credibility and advance goals.
- Use their influence to advocate for the ecosystem in broader communities.

- Avoid spreading resources too thin by trying to engage those resistant to your mission.

Demonstrate Value

To sustain interest and participation, ensure that members and stakeholders see the tangible benefits of being part of the ecosystems network:

- Share success stories of how the ecosystem has impacted individuals or communities.
- Provide resources, training, or opportunities that directly benefit members.
- Regularly articulate how the ecosystem is meeting its goals and addressing members' needs.

Communicate Value

Effectively communicating the ecosystem's purpose and achievements is key:

- Use diverse platforms—newsletters, social media, events—to keep members informed.
- Tailor messaging to different audiences to highlight what the ecosystem offers them specifically.
- Be transparent about challenges, successes, and ongoing efforts to foster trust and engagement.

Measure Impact

An ecosystem thrives when it can show that it is making a difference:

- Develop metrics to assess the ecosystem's success, such as growth in membership, collaborations, or outcomes from initiatives.
- Conduct surveys or interviews to gather qualitative and quantitative feedback from members.
- Share the results to demonstrate accountability and guide future improvements.

Ensure Inclusiveness

Inclusivity ensures that all voices are heard and valued, making the ecosystem more robust and sustainable:

- Actively seek diverse perspectives in decision-making and leadership roles.
- Remove barriers to participation, such as physical access, financial constraints or language barriers.
- Foster an environment where all members feel comfortable sharing their ideas and experiences.

Arrange Convenings

Regular convenings, whether in-person or virtual, are vital for maintaining engagement:

- Host networking events, workshops, or conferences to strengthen connections.
- Use these gatherings to brainstorm solutions, share updates, and celebrate milestones.
- Create opportunities for informal interactions to build deeper relationships among members.

Face Challenges

Acknowledging and addressing challenges ensures the ecosystem remains resilient:

- Identify common pain points, such as resource constraints or member disengagement.
- Develop strategies to overcome obstacles, like seeking external funding or adapting programs.
- Treat challenges as opportunities for growth and innovation.

Highlight Member's Achievements

Highlighting the accomplishments of members boosts morale and engagement:

- Feature their stories in newsletters, on social media, or during events.
- Use member profiles to inspire others and showcase the ecosystem's impact.
- Celebrate diverse forms of success, from professional achievements to contributions to the community.

Governance Structure

A governance structure is essential for a STEM Learning Ecosystem, as for any network, especially community-based, to ensure it operates effectively, achieves its goals, and maintains accountability to its stakeholders. In addition, a clear governance structure can help assembling roles and responsibilities, enhance decision making, build trust and credibility, promote inclusivity and equity and encourage adaptability and growth.

Within the STEM Learning Ecosystems movement, **Local Advisory Boards** have been the prevalent form of governance, where the invited group of individuals from diverse sectors in a community comes together to launch the ecosystem and engage in strategic planning for a shared cause.

If your ecosystem organization is working at the national level in your country, it is crucial to form a **National Advisory Board.**

Local Advisory Board

The purpose of the LABs is to empower communities to shape and execute locally relevant initiatives, foster grassroots engagement, and serve as the ecosystem's local voice. We recommend including local people, grassroots leaders, and stakeholders from the diverse sectors of the SLE model. Ensure participation from underrepresented groups to promote equity. Try to engage 7-15 members, allowing for inclusiveness and operational efficiency and, together, develop long-term vision and goals. Decide, in association with your advisory board, how often the board meets. We suggest two to four times a year.

National Advisory Board

The main purpose of the NABs is to provide strategic guidance, advocate for resources, align national-level initiatives with the ecosystem's mission, and ensure sustainability. When forming your NAB, it is important to include members from key sectors such as government, policy makers, nonprofits, academia, school administrators, industry and community leaders. Prioritize individuals with expertise relevant to the ecosystem’s goals and be sure to ensure geographic diversity to reflect the

interests of various communities. An ideal size of NAB, would be 10-20 members for manageability and inclusivity. Call on the NAB to develop long-term vision and goals for your national ecosystem.

Moving Forward

As we move forward and envision a future of strong and robust collaboration, within and between communities, we must ask ourselves, how do we in the Arctic region communicate the value of the ecosystem approach?

We would like to promote a future of hope in a world that is full of change, dynamic power and opportunity. Hope for the young people that now face a future that many attempt to predict, but first and foremost hope for the collective efforts, the shared visions, strengths and inspirations. The ecosystem approach is in our minds a container for exactly that: For shared hopes and dreams, collaborative efforts, and lessons learned.

But furthermore, the approach strives to exist for the world of tomorrow, to prepare, equip and build skills for tomorrow's opportunities.

Effective Ecosystems Communication

How can we establish effective communication within the ecosystem and between the ecosystems?

Within Ecosystems

Internal ecosystem communication focuses on fostering collaboration among stakeholders; like schools, teachers, researchers, and industry and spark interest within the community, welcoming everyone interested to join the ecosystem. We suggest hosting regular meetings for your ecosystem to meet and identify shared opportunities, challenges and possibilities for collaboration. We recommend you use channels like monthly or quarterly newsletters where you list previous projects and undertakings, where everyone interested can sign up. Social media can play a big role as well, highlighting and communicating the undertakings and the purpose of your ecosystem.

Between Ecosystems

Cross-ecosystem communication fosters resource-sharing, collaboration on larger initiatives, and mutual growth. A STEM Learning Ecosystem is a living network, a breathing thing that will take on a life of its own. The same will apply to cross-ecosystem communication.

As we expand, our vision is to host joint forums, conferences, and workshops to share best practices and innovations. We also envision scheduling regular inter-ecosystem meetings to discuss shared challenges and solutions and to highlight achievements through shared newsletters, blogs, or collaborative publications.

Join us!

If you and your community are interested in establishing a STEM Learning Ecosystem, or if you already have a sign of an ecosystem - please let us know by signing up here so we can include you in our community! Welcome!

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Traill, S., Traphagen, K. and Devaney, E., 2015. Assessing the impacts of STEM learning ecosystems: Logic model and recommendations for next steps. *Assessing the impacts of STEM learning ecosystems: Logic model and recommendations for next steps*.

Traphagen, K. and Traill, S., 2014. How cross-sector collaborations are advancing STEM learning. *Los Altos, CA: Noyce Foundation*.

Volk, S. C. and Schäfer, M. S. (2024). Evaluations in science communication. Current state and future directions *JCOM* 23(06), Y01. https://doi.org/10.22323/2.23060401

UNESCO United Nations Educational, Scientific and Cultural Organization, 2003. International standard classification of education, ISCED 1997. In *Advances in Cross-National Comparison: A European Working Book for Demographic and Socio-Economic Variables* (pp. 195-220). Boston, MA: Springer US.

Other Resources

Some resources that were identified as being useful as part of this project are:

STEM Learning Ecosystem website: www.stemecosystems.org

This website offers background of the STEM Learning Ecosystems movement and examples and links to the current ecosystem organisations globally.

WiSTEM website: https://womeninstem.org/

This student-led international organisation has 221+ chapters in 19 countries.

Girls Who Code: https://girlswhocode.com

An international organisation striving to close the gender gap in technology.

500 Women Scientists: https://500womenscientists.org/

The mission of 500 Women Scientists is to serve society by making science open, inclusive, and accessible and transform society by fighting racism, patriarchy, and oppressive societal norms.

AAUW website: https://www.aauw.org/resources/

Variables for Women´s Success in Engineering and Computing report: https://www.aauw.org/app/uploads/2020/03/Solving-the-Equation-report-nsa.pdf

Gender Pay Gap 2022 report: https://www.aauw.org/app/uploads/2022/12/SimpleTruth_12.22_2.1-002.pdf

The American Association of University Women publishes reports on gender equality, and hosted a variety of resources that can be useful in examining issues relevant to girls and women in STEM,

Appendices A-D in this manual: Items in the Appendices A-D provide the documents the partners used to launch their NPA STEM Learning Ecosystems and Pilot Projects. Here you will find customizable documents that can assist you in launching your projects.

Appendix A

Sample Letter of Invitation for Board Member

Dear …..

We are thrilled that UG has received a Northern Peripheral Arctic grant to support efforts focused on advancing girls and women in STEAM in our community.

This project proposes to use the evidence-based U.S. STEM Ecosystems model, a cross-sector collaborative approach that has achieved significant success in the U.S. over the past decade, to strengthen the organizational capacity among NPA communities and empower communities to build skills for the 21st century. STEM Ecosystems are collaborative partnerships between organisations, schools, industry, museums, libraries, families, individuals, and any others dedicated to working together to develop STEM skills in a community.

By working across borders, this project will empower the communities to gain from each other's resources, knowledge, and strengths and forge stronger solutions to their challenges. By building these cross-sector partnerships and working together transnationally, this project will forge common solutions for more prosperous and resilient communities.

In Galway we already have many strengths in STEM education and industry, as well as a vibrant and rich arts community, plus schools, museums, universities, and family support groups. Our aim is to bring stakeholders from our community together with others across sectors to form a STEAM ecosystem that has the potential to strengthen all involved and provide access to STEAM for traditionally underrepresented groups.

We are convening an Advisory Board made up of stakeholders representing each sector. We will meet for two half-days in late August to map out our community assets and needs and form a strategic vision for a pilot project we will undertake together over the next 18 months. I would be delighted if you would join as a founding Advisory Board Member, given your experience with ….....( ). The commitment will be bi-annual hour-long board meetings, starting with the two half-day sessions that will be co-designing the ecosystem, and identifying a pilot project focused on empowering girls and women in STEAM that we will undertake based on community needs.

Scheduled Advisory Board meetings, to be held on campus at University of Galway:

August 28: 3-6 pm

August 29: 10 am-1 pm

Please let me know by August 1 if you are willing and able to join this community. I believe this project will greatly strengthen the work we are all already doing and connect us to other similar ecosystems around the Arctic, and the world.

Appendix B

Sample Pre-work documents

Pre-work for August 28 & 29 workshops: PART 1

Thank you for joining the STEAM Galway strategic planning workshops.

On Monday we will work together to develop the Vision statement that addresses the question- what does the next 25 years look like for girls and women in STEAM in Galway?

Please take some time to prepare your responses before you arrive at Monday´s workshop and bring your completed worksheets with you to the workshop.

a. What is STEAM Galway´s role in the community today?
(This refers the group as it exists today.)

b. What do you see as STEAM Galway´s role in the community over the next decade or two?

c. What differentiates STEAM Galway from other similar community service organizations?

d. What defines "success" for STEAM Galway?

Pre-work for August 28 & 29 workshops: PART 2

In preparation for the August 28 & 29 STEAM Galway workshop, please detail your perception of the strengths, weaknesses, opportunities and threats ***to girls and women in STEAM in the Galway region***.

In the session we will consolidate, analyse, prioritize and create issues that the organization must address in the strategic planning process.

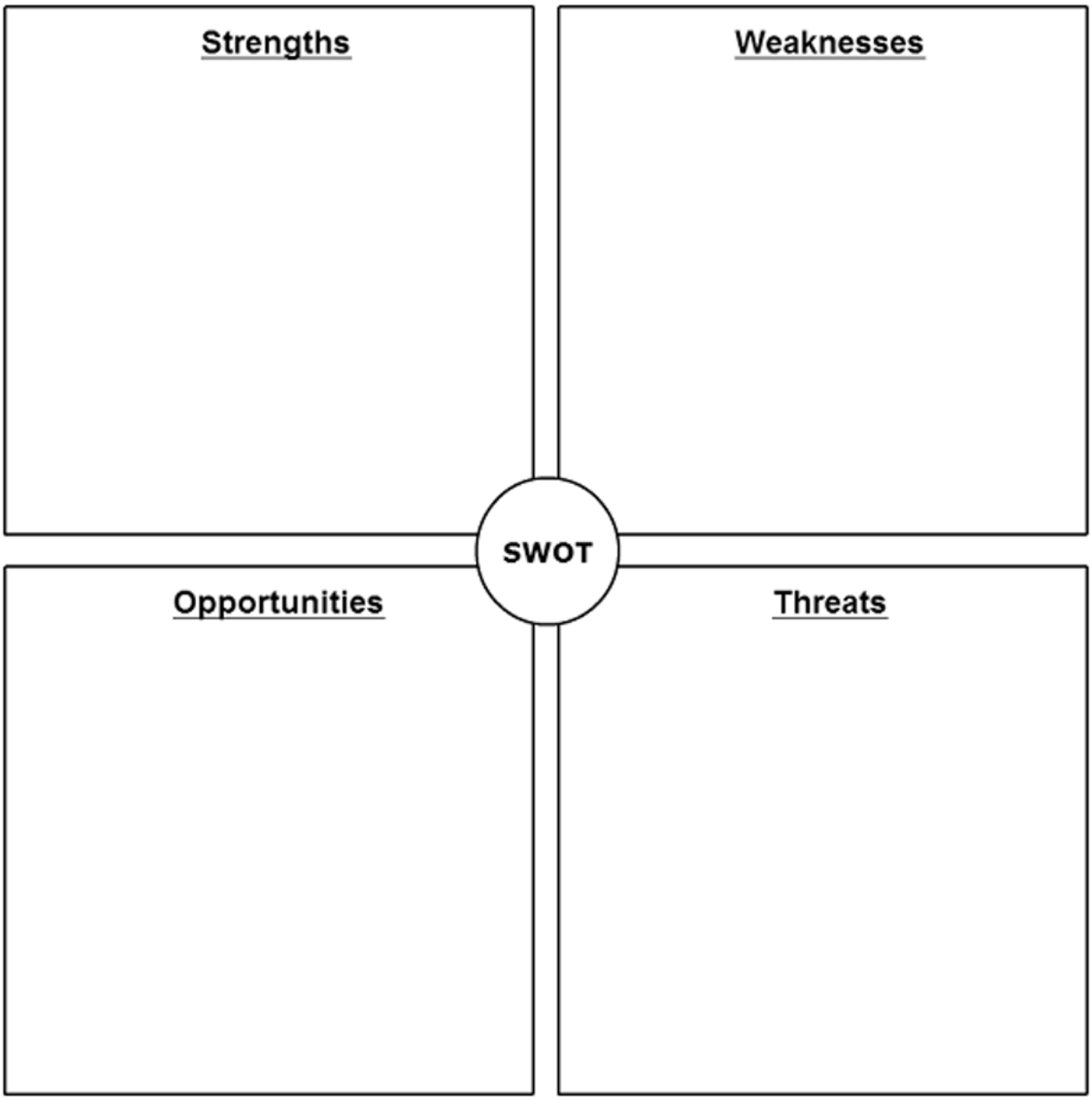
SWOT
The SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) created by Albert Humphrey is an exercise that will rate each task as a S.W.O or T to create a hierarchy of resources.

- **Threats** need the most immediate action
- **Weaknesses** may need some kind of temporary or permanent assistance
- **Opportunity** needs analysis to determine if resources are available to pursue without hurting Strengths or creating a Weakness
- **Strengths** are left as-is only if there are no W's, O's or T's that need attention.

SWOT ANALYSIS

Please detail your perception of the strengths, weaknesses, opportunities and threats ***to girls and women in STEAM in the Galway region***.

SWOT ANALYSIS


Strengths
Weaknesses
SWOT
Opportunities
Threats

Appendix C

Sample agenda

Workshop agenda LUMA Lapland, Finland - November 6

9:00-9:25 **Introductions, set norms, and welcome (Finnish)**
9:25-9:45 **NPA & STEM Learning Ecosystems Presentation (Huld)**
9:45-10:00 **LUMA Lapland Introductions (Pekka)**
Org. Introductions - they have 1 minute elevator pitch only- why are they here. Tell us one thing about you that no one else knows

10:00-10:15 **Break**
10:15-11:10 **Values & Vision Statement for girls and women in STEAM in Lapland**
Value definition: what has already been done?

10:15-10:30 Action: everyone breaks into small groups of 4-5 someone they don´t know and each group defines 2 values. Do we need to add to these?
10:30-10:40 Action: *groups report back to larger group – B or H is writing on a large poster and slides*
10:40-11:20 Action: Groups form vision statement for girls and women in STEAM.
This is ideal. Lofty. What is the big bold vision we hold for girls and women in STEAM based on these values?
Take pre-work documents as reflections and small groups of 4-5 work for 25 mins on a vision. A clear succinct vision statement people can remember.

Action: I facilitate the bold vision statement from group statements.
Put up on the board and everyone sees it & refer back to it- do we need to modify it or change it from what we have just done?

11:20 - 11:55 **Intro to Situation analysis: Where are we today with girls and women in STEAM in Lapland?** (Needs to be someone from Lapland, address SAMI)

Action: *We have a presentation of facts first-LUMA*
(Provide some slides and websites)

11:55 – 12:45 Wrap up and Break for lunch

12:45-1:30 **Situation Analysis:**

Where are we today with girls and women in STEAM in Lapland?

12:45-1:00 Action: *Staying in small groups of 4-5, Each group generates top three statements and shares to full group.*

1:00-1:15 Action: I facilitate the top three statement of the full group.

1:15-1:30 Action: I ask the questions of the large group: What do we need to do to get to our vision? Group think. B or H takes notes on the board.

1:30-2:00 **Break and Asset mapping: gallery walk around town map**

2:00-3:00 **SWOT Analysis: 4 small groups**
SWOT Analysis specific to girls and women in STEAM) include in instructions that they should include any larger issues that they identify
2:00-2:40 *Action: People mix it up in different groups and work from pre-work sheets to fill large post it poster on their table with their group.*
2:40-3:00 merge into one large group SWOT paper

3:00-3:30 **Selection of 3 potential pilot projects**
Groups present, and I facilitate the group ranking the top opportunities.

Top three become potential pilot projects and can go on a public Exit Ticket

3:45-4:00 **Wrap-up and closing**

Materials needed: (Oona)

Large map of Lapland

PISA scopes etc on data on girls and women in STEAM in Lapland

(Send out 2 pre-work docs on values and SWOT)

Large poster on easel or 4 sticky notes on wall for SWOT

Sharpies

Copies of pre work sheets

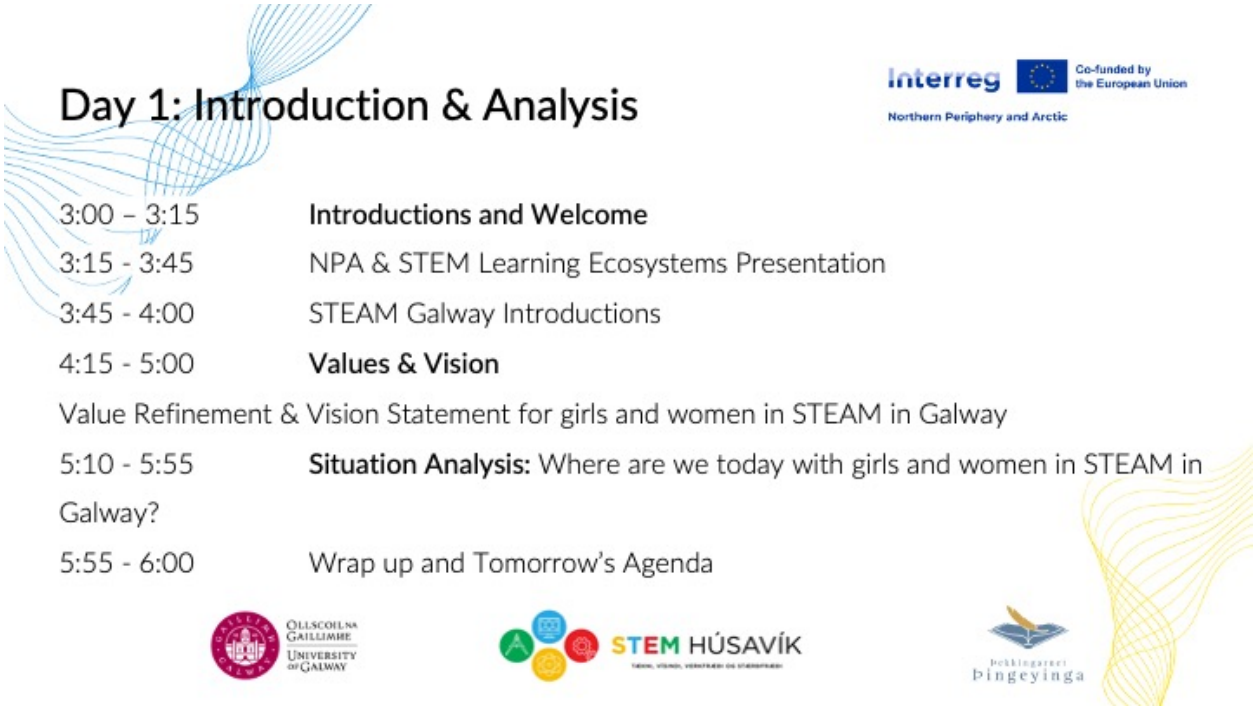
Set up round tables in small groups

Coffee and snacks

SLE folder of materials

Appendix D

Visual Aids



Goals of the workshop

Goal #1: Educate and inform about the NPA project and SLE model both advisory board

Goal #2: Form an advisory board representing each sector in the SLE to form a vision for the project (Vision statement)

Goal #3: Identify need with relation to girls and women in STEAM in region(Situation Analysis)

Goal #4: Identify who is here, who can participate and what are they doing- (Asset map)

Goal #5: Identify three potential pilot projects using the SWOT, vision, situation analysis & asset map

Background

2500 inhabitants


Húsavík Ecosystem / Advisory Board
Interreg Co-funded by the European Union
Northern Periphery and Arctic
HÁSKÓLI ÍSLANDS
HAUKAMÝRI
FAB LAB
Hraðið miðstöð nýsköpunar
Þekkingarnet Þingeyinga
SVÍVS
Borgarhólsskóli Húsavík
STEM HÚSAVÍK
TÆKNI, VÍSINDI, VERKFRÆÐI OG STÆRÐFRÆÐI
THE HÚSAVÍK WHALE Museum
pcc Bakki Silicon
Náttúrustofa Norðausturlands
Framhaldsskólinn á Húsavík
Frumkvæði - Samvinna - Hugrekki
Ocean Missions
Sponsors
Interreg Co-funded by the European Union
Northern Periphery and Arctic
SÓKNARÁÆTLUN NORÐURLANDS EYSTRA
UPPBYGGINGARSJÓÐUR
FULBRIGHT Iceland
ICELAND - UNITED STATES EDUCATIONAL COMMISSION
Þekkingarnet Þingeyinga
Interreg Co-funded by the European Union
Northern Periphery and Arctic
Landsvirkjun
National Power Company of Iceland
UNITED STATES OF AMERICA EMBASSY
LÓA
Barnamenningarsjóður Íslands

Arctic STEM Communities

Interreg Co-funded by the European Union
Northern Periphery and Arctic

- For the first time, one small-scale project has been approved under Priority 3 – Cooperation opportunities
- The project will facilitate collaborative partnerships between organisations, schools, industry, museums, libraries, families, individuals, to develop STEM skills in a community.
- **Arctic Stem Communities** will have a special emphasis on equity and access that can help to empower and equip communities facing the challenges of the future.

Ollscoil na Gaillimhe University of Galway
STEM HÚSAVÍK
Þekkingarnet Þingeyinga

Arctic STEM Communities

Interreg Co-funded by the European Union
Northern Periphery and Arctic

- 18 months; June ´23 to November ´24
- Establishing the STEM Learning Ecosystems model; facilitate asset mapping, SWOT analysis and Vision Statement - that will result in
- Three possible pilot projects in each community
- Collect data
- Publish a Community Manual around the implementation process

Ollscoil na Gaillimhe University of Galway
STEM HÚSAVÍK
Þekkingarnet Þingeyinga

STEM Learning Ecosystems

Interreg Co-funded by the European Union
Northern Periphery and Arctic

STEM ecosystem Cultivate. Learn. Innovate. TIES Uniting Partners. Transforming Learning.

➔ 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.

Ollscoil na Gaillimhe University of Galway
STEM HÚSAVÍK
Þekkingarnet Þingeyinga

STEM Learning Ecosystems

Interreg Co-funded by the European Union
Northern Periphery and Arctic

111+ STEM LEARNING ECOSYSTEMS

1,980+ SCHOOL DISTRICTS REPRESENTING RURAL, URBAN AND SUBURBAN AREAS

2,315+ HOURS DEVELOPING STEM LEADERS

42M+ PREK-12 CHILDREN

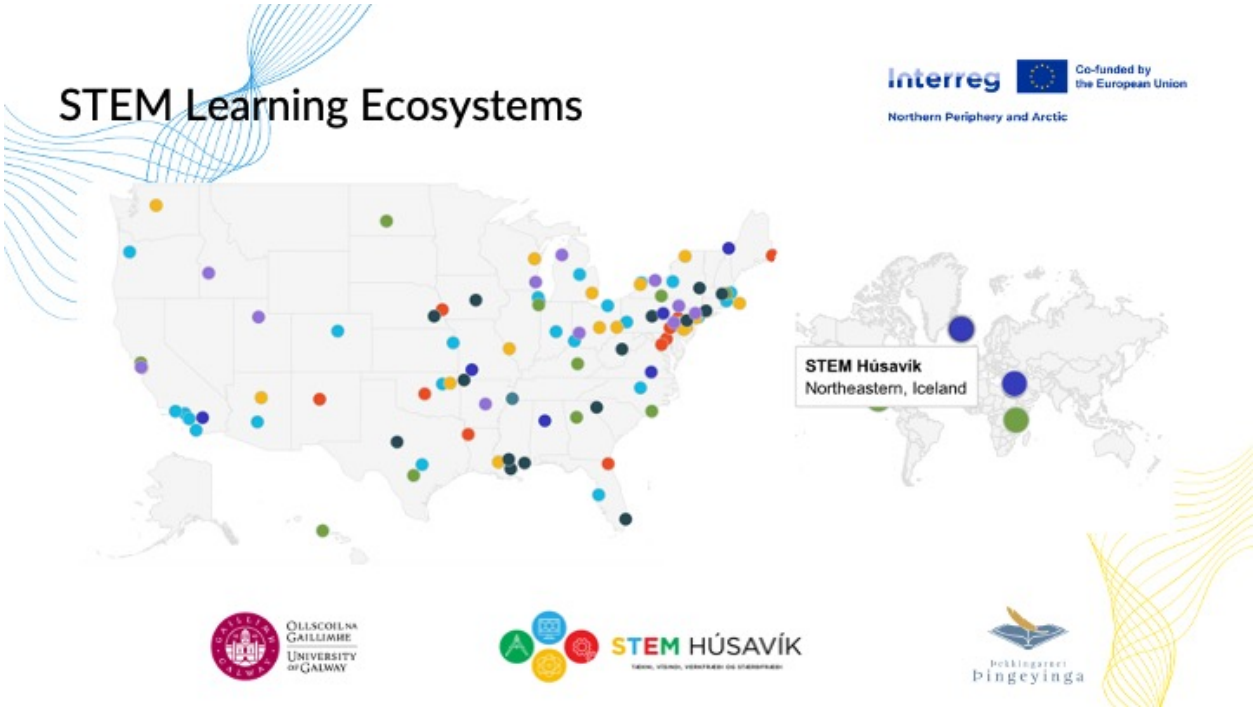
900K PREK-12 TEACHERS & INFORMAL EDUCATORS

1,270+ INFORMAL & OUT-OF-SCHOOL TIME PARTNERS

4,600+ PHILANTHROPIC, BUSINESS & INDUSTRY PARTNERS

6,635+ HOURS CULTIVATING REGIONAL STEM LEARNING ECOSYSTEMS

Ollscoil na Gaillimhe University of Galway
STEM HÚSAVÍK
Þekkingarnet Þingeyinga


STEM Learning Ecosystems
Interreg Co-funded by the European Union
Northern Periphery and Arctic
STEM Húsavík
Northeastern, Iceland
Ollscoil na Gaillimhe University of Galway
STEM HÚSAVÍK
Þekkingarnet Þingeyinga


STEM Learning Ecosystems
Interreg Co-funded by the European Union
Northern Periphery and Arctic
Ollscoil na Gaillimhe University of Galway
STEM HÚSAVÍK
Þekkingarnet Þingeyinga

Elevator Pitch

1 minute: Why are you here?

And tell us one thing about you that no one else knows...

Core Values

What are the core values that represent STEAM Galway´s brand?

Existing values:

- ★ Curiosity
- ★ Inclusion
- ★ Making a Difference
- ★ Fun
- ★ Openness
- ★ Empathy
- ★ Creativity
- ★ Belonging

Core Values

Interreg Co-funded by the European Union
Northern Periphery and Arctic

What are the core values that represent STEAM Galway´s

Values recorded during workshop:

Core Purpose/Vision Statement

Interreg Co-funded by the European Union
Northern Periphery and Arctic

What is that STEAM Galway will offer over the next two decades that represents Mission Achievement toward girls and women in STEAM?

- ★ Make it timeless
- ★ Keep it basic
- ★ Avoid lingo
- ★ Should be aspirational
- ★ Make it long term
- ★ Keep it short
- ★ Build your team to dream BIG
- ★ Imagine the future of what can be
- ★ Use active words

Core Purpose/Vision Statement

What STEAM Galway will offer over the next two decades:

An interconnected community built on respect, openness, curiosity and empathy. We work together using diverse and creative STEM practices to:

- Foster engaging lifelong learning in and out of the classroom
- Tackle societal challenges
- Make a positive difference for all

Situation analysis:

Where are we today with girls and women in STEAM in Galway?

Situation analysis:

1. There is no well-defined interdisciplinary STEAM education pathway*

2. Girls and women lack self-efficacy in their abilities to enter the STEAM education and career pathways

3. Young people from disadvantaged populations and areas are disproportionately underrepresented in STEM

*Learning Certs define pathways is either or for STEM arts.. middle school age 15 from an early age girls are asked to choose between STEM and arts... as an educational pathway. In high school, tracking and scheduling prohibits. At higher ed are impossible to combine degrees.

Day 2: Strategic Planning

Galway City Museum

10:15 - 10:30	Introductions if needed and review of Yesterday´s session
10:30 - 11:00	Asset mapping: Gallery walk around town map
11:00 - 11:15	Break
11:15 - 12:00	SWOT Analysis : small groups
12:00 - 12:45	Selection of 3 potential pilot projects
12:45 - 1:00	Wrap up and Closing

Asset Mapping

SWOT Analysis

Strengths	Weaknesses
Passion to tackle issues / University town School + teachers are driving change / Size is good Strong local culture of STEAM Abundant/rich resources (asset map) SciFest - WISTEM - Strong science foundation in community Strong female role models in STEAM "You can see it - be it" / Marine Science	The group has limited capacity to effect systemic change at this time No funding - hard to find long-term funding Working with the same audience Champions within the network are not well-informed or well connected
Opportunities	**Threats**
"Educate together" provides an opening Several female leaders at university level can be tapped as key allies at ATU Several know organisations have trusted relationships with disadvantaged communities Generative AI is a game changer, allowing for new opportunities for STEAM Early education Finding out what works in STEAM through research Building the network itself is an opportunity	Gender bias is alive and well in Galway The communication on the data around gender gap is insufficient STEAM pathways are not well defined Education system is designed to drive the higher Cert- test scores The government policies favor outcome vs. process (higher education attainment toward a career) Schooling is sectarian Teachers don't have a lot of extra time (post covid) Art tokenism in STEAM Urban-rural divide / Digital divide Exclusivity in presentation and delivery of STEM programs Education not valued or trusted within communities and/or families

Pilot Projects

1. Workshop series on embodied cognition in Physics subjects in compulsory schools, from a Master´s student in ATU.
1. A flexible and adaptable evaluation tool or approach to STEAM initiatives and sharing it.
1. Leadership forum around girls and women in STEAM that meets 3 x/year to listen to broadest community needs and raise visibility to support the network.
1. Launch a working group to develop a set of recommendations for STEAM education pathways at university level building a transdiciplinary approach, with focus groups in secondary level, with possible 6-8 week transition year curriculum
1. Grant writing and fundraising guide - how to secure STEAM funding and collaboration

Wrap up & Thank you!

We did it!

Connecting Húsavík, Iceland
to Galway, Ireland

Wrap up & Thank you!

STEM Learning Ecosystems further reading

http://stemecosystems.org/wp-content/uploads/2015/11/Assessing_Impact_Logic_Model_Template_STEM_Ecosystems_Final.pdf

https://stemecosystems.org/wp-content/uploads/2017/01/USD-Critical-Factors-Final_121916.pdf

https://eric.ed.gov/?id=EJ1249559

https://mybrainware.com/blog/stem-and-sel-a-perfect-match/

https://www.invent.org/blog/diversity-in-stem/teach-empathy-collaboration-skills

https://www.vivifystem.com/blog/2020/6/12/boost-social-emotional-learning-with-stem

Appendix E

Example Vision, Mission, Values Statements

Sample 1: Girls Who Code
Vision is to close the gender gap in technology.

Mission: To support women in STEM and increase the number of women in the workplace.

Values: Bravery, sisterhood, and activism

Sample 2: The American Red Cross
Vision: The American Red Cross, through its strong network of volunteers, donors and partners, is always there in times of need.

Mission:
The American Red Cross prevents and alleviates human suffering in the face of emergencies by mobilizing the power of volunteers and the generosity of donors.

Sample 3: IKEA
Vision: To create a better everyday life for the many people.

Mission: To offer a wide range of well-designed, functional home furnishing products at prices so low that as many people as possible will be able to afford them.

Values: Lead by example, togetherness, people and planet, cost consciousness.