



# INFORMAL STEM EDUCATION POLICY



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# INFORMAL STEM EDUCATION POLICY

## INTRODUCTION

Science, Technology, Engineering, and Mathematics (STEM) have always been a part of the lives of families and communities. In addition to recognizing the expertise in STEM knowledge and practices that citizens develop through participation in everyday life activities, many countries across the world also consider STEM essential to economic development and societal advancement. As nations seek to develop a skilled and responsive workforce, STEM education is often a key policy priority.

Globally, informal STEM education is viewed as an integral component of a comprehensive STEM education system and as a way to promote educational equity. Informal learning experiences can create a foundation for individuals to build upon existing STEM knowledge, discover an interest in the STEM fields, develop the motivation to pursue further learning, and build an identity as a person who uses STEM in the personal, professional, and civic aspects of their lives. These outcomes indicate the importance of STEM learning opportunities that take place outside of school as a complement to learning in the classroom.<sup>1</sup>

Both of these global trends—an emphasis on STEM to encourage strong economic and social development, and a growing recognition that informal and lifelong learning are essential to STEM education—are evident in Thailand. Thailand has long recognized the importance of STEM to promote the quality of life for individuals and families and the development of the nation as a whole. Additionally, Thai leaders understand that increasing access to and broadening participation in informal and lifelong STEM learning are necessary to create a more equitable society that focuses on multiple ways of knowing in STEM.

## THAILAND 4.0

STEM is considered critical to the success of Thailand 4.0, an initiative with three interrelated key elements: (1) to transform Thailand into a high-income nation by developing a knowledge-based economy focused on research and development, science and technology, creative thinking, and innovation; (2) to move toward an equitable society with shared access to the benefits of prosperity and development; and (3) to provide sustainable growth and cultural development that benefits communities and the economy without harming the environment. Thailand 4.0 is sometimes described as “smart industry + smart city + smart people” to emphasize its interrelated socioeconomic, technological, and human aspects.

To achieve the vision of Thailand 4.0, Thailand’s government is creating policy and incentives that promote investment in five key areas. These are (1) developing human resources, (2) building technology clusters and future industries, (3) incubating entrepreneurs and enterprises, (4) strengthening the internal economy and infrastructure, and (5) integrating Thailand into the Association of Southeast Asian Nations (ASEAN) and the global economic community. To realize the vision of Thailand 4.0, the Ministry of Science and Technology, the Institute for the Promotion of Teaching Science and Technology, and the Ministry of Education all recognize STEM education as a policy priority at the national and regional level.

## INFORMAL STEM EDUCATION POLICY

<sup>1</sup> Banks, J.A., Au, K.H., Ball, A.F., Bell, P., Gordon, E.W., Gutierrez, K., Heath, S.B., Lee, C.D., Lee, Y., Mahiri, J., Nasir, N.S., Valdes, G., & Zhou, M. (2007). Learning in and out of school in diverse environments: Life-long, life-wide, life-deep. Seattle, WA: UW Center for Multicultural Education & The LIFE Center.

# INFORMAL STEM EDUCATION IN THAILAND



There is widespread agreement among policy makers and educators that Thailand's future workforce requires strong STEM preparation, as well as related 21st century skills such as problem-solving and creativity. As a result, both public and private entities are investing in STEM education at all levels and in all settings. Currently, the Thai government provides formal STEM education through primary and secondary schools, vocational schools, colleges, and universities; non-formal STEM education through structured courses and trainings; and informal STEM education through organizations such as museums, libraries, community learning centers, and science camps.

Informal STEM learning experiences can play a key role in Thailand's human resources development agenda. A robust informal STEM education system will help Thai youth develop interest and motivation to study STEM subjects and work in STEM-related fields. It will support culturally meaningful STEM learning and encourage Thai youth to develop STEM identities. Deeply engaging the diversity of STEM knowledge and practices from various regions and communities in Thailand will also encourage adult Thais to participate in lifelong, life-wide, and life-deep STEM learning and to contribute traditional knowledge to STEM endeavors.<sup>2</sup> Expanding engagement and participation in STEM learning within and across settings could support the development of STEM expertise and allow young people, families, and communities to imagine and design thriving futures.

## POLICY RECOMMENDATIONS

This document identifies key policy actions to leverage informal educational environments to deepen STEM learning pathways and accelerate the development of a technologically driven, culturally flourishing, and inclusive economy as reflected in the vision for Thailand 4.0. The recommendations presented here are informed by a series of workshops in Bangkok and regions of Thailand, in which a range of STEM education thought leaders, policymakers, researchers, educators, and field practitioners from the government and diverse informal education institutions exchanged ideas and developed recommendations. Through online surveys, Thai classroom teachers also contributed information about issues such as their teaching practices vis-à-vis formal and informal STEM education. Emerging recommendations from Thai stakeholders were refined with input from international experts in the field of informal STEM learning, and then finalized based on further expert review in Thailand.

## POLICY RECOMMENDATIONS

<sup>2</sup> For a summary of pertinent research, see the 2014 special report by the Scientific American, How diversity powers science and innovation. <https://www.scientificamerican.com/report/how-diversity-empowers-science-and-innovation/>

The goal of this policy brief is to make informal STEM education a core part of Thailand’s overall STEM education policy. The document outlines six interrelated recommendations that build on the Thai government’s priority to strengthen STEM education and identifies opportunities for innovative and impactful implementation them in communities across the country:

**1. ENGAGE FAMILIES AND COMMUNITIES:**

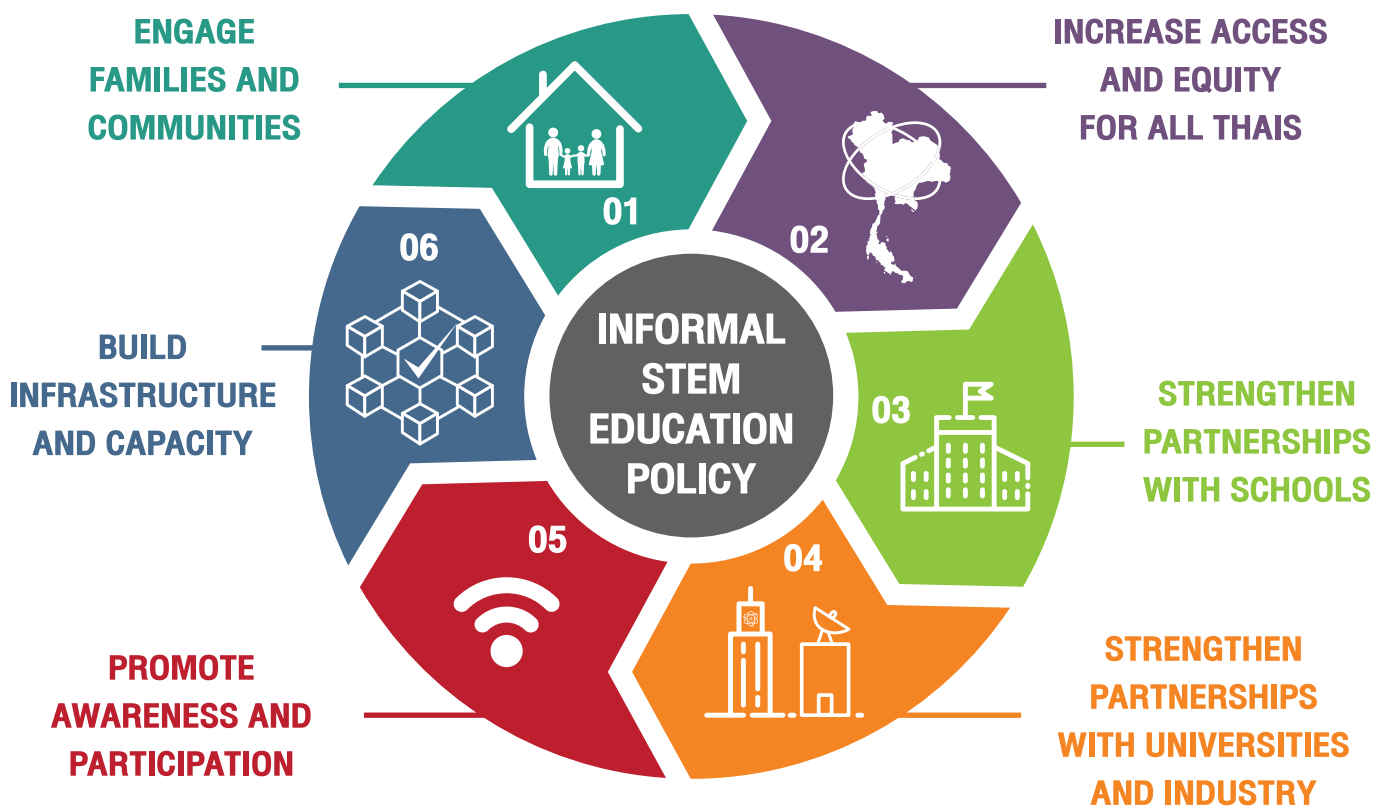
Design informal STEM education programs to engage families and communities in learning together by focusing on families’ and communities’ interests and providing clear roles and supports for diverse participants;

**2. INCREASE ACCESS AND EQUITY FOR ALL THAIS:**

Improve access to and awareness of informal STEM education in all communities, especially remote and underserved regions of Thailand;

**3. STRENGTHEN PARTNERSHIPS WITH SCHOOLS:**

Develop collaborations among informal learning organizations and formal educational institutions, using their complementary strengths to foster learning for youth and to achieve shared goals related to STEM learning;



**4. STRENGTHEN PARTNERSHIPS WITH UNIVERSITIES AND INDUSTRY:**

Establish partnerships among informal STEM learning organizations, universities, research institutes, and industry to leverage expertise and resources across Thailand;

**5. PROMOTE AWARENESS AND PARTICIPATION:**

Utilize a strategic combination of proven and innovative public media, large-scale events, and online learning experiences to recruit and engage Thai people of all ages in intergenerational, community-based learning in all parts of the country;

**6. BUILD INFRASTRUCTURE AND CAPACITY:**

Invest strategically to increase Thailand’s capacity for informal STEM education through professional development and a competitive grant funding program, and establish management systems to carry out all six recommendations.

# 01 ENGAGE FAMILIES AND COMMUNITIES

*Create informal STEM education programs that engage families and communities in learning together.*

Parents and the surrounding community have a profound impact on children's education and career aspirations and choices. Parents' knowledge, attitudes, and skills related to STEM can influence children's early learning opportunities related to STEM and the development of their identity as a STEM learner. Similarly, the needs, perspectives, expectations, and resources in a community can shape the ways in which individuals and families view and participate in STEM learning and careers.

In order for youth to make the choice to pursue advanced STEM learning and a career in a STEM field, they must be supported by their families and communities. STEM learning experiences outside of school can help build this support. Furthermore, for STEM to be accepted, applied, and encouraged, STEM knowledge needs to co-exist and be integrated with family members' cultural practices, personal experiences, and the values of the community.<sup>3</sup> Family knowledge and cultural practices are assets that can help more Thai youth develop interest and motivation to pursue STEM education and careers.

## RECOMMENDATION AND STRATEGIES

01



Design informal STEM education experiences to support STEM learning among all members of a family in ways that are intergenerational and culturally grounded in order to promote positive attitudes and lifelong STEM learning throughout the community.

02



Encourage families and community members to support youth interested in STEM and help them identify pathways to continue to develop their interest, in and out of school, so that a broad variety of individuals can learn about and pursue STEM careers.

03



Create informal STEM education programs that engage, respond, and incorporate the interests, worldviews, and concerns of target communities, so that the programs are relevant and emphasize the potentials of STEM to improve the quality of life in Thailand.

04



Involve community members in designing, planning, and implementing informal STEM education programs so that STEM concepts and skills are interwoven with local wisdom, histories, and knowledge systems in order to expand STEM learning as a culturally meaningful, community-wide activity.

<sup>3</sup> Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education*, 94(6), 1008-1026.

## CURRENT PRACTICES IN THAILAND



Thai experts agree that when implementing informal STEM programs, it is essential to engage community knowledge, practices and values related to STEM. While many agree that Thailand has the potential to offer high quality programs for families and communities, stakeholders believe that educators across the country need to become better aware of and utilize best practices for family and community engagement.<sup>4</sup>

An innovative program at Sahasat Suksa school, an urban school in the north of Thailand, provides an example of school leadership, teachers, students, and families coming together to create a teaching and learning network that uses local wisdom as the basis of the STEM curriculum. Students work with their families to identify practices and knowledge that are important to them and use them as contexts for learning STEM, such as bamboo Akha games, mango harvesting, and trap fishing.

Thailand's existing infrastructure could be leveraged to develop family and community engagement programs. For example, Community Learning Centers (CLCs) could be utilized to create a network of partners that provide and coordinate non-formal and informal education activities locally. Stakeholders have also identified other facilities, such as Thailand Knowledge Park (TK Park) and makerspaces, that could be replicated across the country to support family and community engagement in informal STEM learning.

## EXEMPLARY PROGRAMS AND PRACTICES

To expand upon promising work done in Thailand, the country can review successful practices in family and community engagement in other areas of the world and apply them to the Thai system. In particular, family-centered learning programs and participatory design partnerships would allow new Thai programs to be created by and for local communities.

Family visits to science museums are one important way parents and children are involved together in STEM learning. Informal learning research has examined how museums can design exhibits and programs that engage the entire family. For example, the Family Science Learning Project of the Philadelphia-Camden Informal Science Education Collaborative (PISEC), led by The Franklin Institute, identified design strategies that encourage family learning at hands-on museum exhibits.<sup>5</sup> Mean while, Researching the Value of Educator Actions for Learning (REVEAL) by Oregon Museum of Science and Industry (OMSI) identified

facilitation strategies that support family learning at exhibits.<sup>6</sup> Science museums in Thailand can utilize these and other techniques to encourage intergenerational learning.

Research indicates that the most robust community projects begin with community support and succeed through collaborative development with community members and organizations. Community partners understand local assets, opportunities, needs, and barriers, and can help build programs that local people are motivated to participate in. PISEC, OMSI, and other organizations have developed extensive partnerships with other organizations to reach underserved communities, both at the museum and those at other locations. The New York Hall of Science's NYSCI Neighbors program embeds museum components within the local community and provides opportunities for young people and their families to participate in creative STEM learning and career development programs.

**ENGAGE FAMILIES  
AND COMMUNITIES**

4 Pruekpramool, C. (2016). Using community resources as funds of knowledge to promote science learning in Thailand. In M.-H. Chu, Ed., *Science education research and practice in Asia: Challenges and opportunities*. Singapore: Springer, 553-568.

5 Borun, M., & Dristas, J. (1997). Developing family-friendly exhibits. *Curator* 40(3), 178-196.

6 Pattison, S.A., Randol, S.M., Benne, M., Rubin, A., Gontan, I., Andanan, E., Bromley, C., Ramos-Montañez, S., & Dierking, L.D. (2017). A design-based research study of staff-facilitated family learning at interactive math exhibits. *Visitor Studies* 20(2), 138-164.







## 02 INCREASE ACCESS AND EQUITY

*Improve access to and awareness of informal STEM education in all communities, especially remote and underserved regions of Thailand.*

Thailand seeks to develop a workforce that is innovative and creative, has both general competency and specialized talent in the STEM fields, and takes advantage of the diverse perspectives, knowledge, and abilities of the Thai people. At the same time, the country wants to ensure that all Thai people benefit and have the opportunity to participate as the economy grows and changes. Statistics on demographic representation in the STEM fields are not available for Thailand, but experts interviewed for this policy brief agree that disparities likely exist.

Today, families that live in remote areas of Thailand do not have access to regular and frequent engagement in structured informal STEM learning experiences. As a result, youth in these areas most likely do not have the same level of family and community support to study STEM and prepare for STEM careers within a traditional framing of the endeavor, although they are likely to engage in STEM-related practices and learning as part of everyday life. In contrast, young people who live in urban areas and whose families are of middle to high socioeconomic status are more likely to have access to resources that support interest in traditional STEM careers. To meet Thailand's goals for the future, special efforts are needed to reach and include everyone in a potential future in STEM.

### RECOMMENDATION AND STRATEGIES

- 01  Identify underserved and underrepresented populations and establish which of these groups are priorities for informal STEM education efforts. For example, geographic priorities might include rural areas, the southern provinces, and the northern mountainous regions, while ethnic and/or religious group priorities might include Muslim populations, hill tribe community members, and linguistic minorities.
- 02  Develop the capacity of museums to act as hubs that serve priority groups within their regions, reaching more diverse audiences at their own facilities and through expanded outreach programs and partnerships with CLCs and facilities located in all areas of Thailand.
- 03  Through these partnerships, create or adapt informal learning programs that are specifically tailored and relevant to priority groups and communities in their regions, using best practices such as community-based design, co-creation, and co-development.
- 04  Incorporate art and design into STEM programming to encourage broader participation from diverse groups and to increase their interest and engagement in STEM. A “STEAM” approach provides opportunities for play-based, imaginative, and creative activities infused with STEM concepts, which encourage inquiry, innovation, and problem-solving.
- 05  Broaden what counts as STEM-related knowledge and practices in order to connect STEM to the cultural histories of underserved and underrepresented communities, and to make conceptual bridges between culture, the arts, and professional science endeavors.
- 06  Work at both a national and a regional level, involving not only national agencies but also municipalities and subdistrict administration organizations in the development and implementation of informal STEM learning initiatives in their localities.



## CURRENT PRACTICES IN THAILAND



The Thai government is committed to providing equitable learning opportunities to people in all parts of the country. To meet this goal, the National Science Museum offers outreach programs such as Science Caravans, Mobile Museum, and Science Express that bring hands-on STEM activities to schools and communities across the country. The museum also produces television, radio, and other mass media to reach lifelong learners across Thailand. However, most interactive informal STEM opportunities are concentrated in urban and central areas, and it is difficult for existing outreach programs to regularly visit rural and remote regions of the country.

Some organizations such as the Inter Mountain Peoples Education and Culture in Thailand Association (IMPECT) are building local STEM education programs that prepare highland groups for civic and economic participation. IMPECT emphasizes learning both Thai and the P'gaz K'Nyau systems of knowledge, and works with community leaders to design learning spaces that interweave local STEM epistemologies with Western ones.

Thailand can broaden participation in STEM learning by increasing equitable access to informal learning opportunities and recognizing local STEM practices within families and communities. In this effort, Thailand can build on existing partnerships to create a more comprehensive and integrated STEM educational system.

## EXEMPLARY PROGRAMS AND PRACTICES

Worldwide, there are a variety of programs that address equity, access, and inclusion in informal STEM education. Many of these utilize best practices by developing programming together with participating communities and integrating their local wisdom. Others take a STEAM (science, technology, engineering, arts, and math) approach that draws from and connects to arts and design along with STEM in order to attract broader participation.

Cosmic Serpent, led by the Indigenous Education Institute, uses STEM as an entry point for museum programs and exhibits.<sup>7</sup> Native Universe: Indigenous Voice in Museums continues this work by infusing indigenous voice in programs and exhibits focusing on environmental change. These programs bring educators and community

members together to co-create STEM educational experiences, building on the knowledge and practices that exist in the community.

At the Hirshhorn National Museum of Modern Art in the United States, ARTLAB+ is a free after school digital arts program that helps teens develop marketable technological skills to lead the next generation of innovators. The ArtScience Museum in Singapore is entirely dedicated to the intersection of art, science, culture, and technology, and offers interactive STEAM exhibits, events, and hands-on workshops.

Another successful strategy can be to introduce high-quality STEM activities at facilities that are accessible to and trusted by community members. In Canada, Community Science Clubs are located in community centers, where they provide free STEM-based afterschool programs

for underserved youth in grades K–8. Thailand could consider establishing such programs at schools or in CLCs.

Some programs designed to broaden participation in STEM have been developed locally and then successfully scaled up to reach national and international audiences.

In Europe, the Hypatia project works to engage girls ages 13–18 in STEM. Coordinated by the NEMO Science Museum in the Netherlands, the program is a collaboration of multiple partners, including science museums, schools, research institutions, and industry. Through a system of 14 hubs across Europe, resources are shared with each participating organization to offer gender-inclusive activities, programs, and events.

<sup>7</sup> Maryboy, N.C., Begay, D., & Peticolas, L. (2012). *The Cosmic Serpent: Bridging native ways of knowing and Western science in museum settings*. Friday Harbor, WA: Indigenous Education Institute.

## 03 STRENGTHEN PARTNERSHIPS WITH SCHOOLS

*Develop collaborations between informal learning organizations and formal educational institutions, using their complementary strengths to achieve shared goals related to STEM learning.*

By taking advantage of the distinct strengths and different approaches of formal and informal education, Thailand can reinforce and amplify learning in each context. Research demonstrates that there are shared learning outcomes related to STEM, yet informal and formal education each have distinct roles to play around specific dimensions of learning.<sup>8</sup> It is often easier to promote interest and identity development related to STEM in informal learning environments, while it is more feasible to promote conceptual learning and epistemic knowledge development through sustained empirical investigations in formal learning environments. Together, informal and formal STEM education support a lifetime of STEM learning, from initial interest through the development of an identity as a science learner, and, in some cases, pursuit of a STEM career.<sup>9</sup>

Partnerships between formal and informal education organizations can bring together their varied expertise, opportunities to design engaging environments to encourage STEM learning for young people and their families. Informal STEM programs can intentionally find ways to align with the goals of formal education by enacting a shared vision of K–12 STEM education. In this effort, it is important to maintain the characteristics of informal education that provide distinct and complementary benefits to learning that takes place in school. To reach and successfully engage students who have not already developed interest in STEM learning and potential careers through school day learning, informal education venues can focus on informal STEM education techniques that attract voluntary participation and support stimulation of interest, curiosity, exploration of conceptual knowledge.

## RECOMMENDATION AND STRATEGIES

01



Better articulate the shared goals and complementary roles of formal and informal STEM education in Thailand. Develop a shared vision for K–12 STEM education to engage in partnerships focused on connecting STEM learning that occurs in and out of school, taking advantage of the distinct strengths of formal and informal education.

02



Enhance capacity by providing funding, resources, incentives, and strategies for formal educators to work with community leaders and informal educators to design and implement informal STEM educational activities in afterschool and other out-of-school programs, particularly in rural and remote areas where fewer dedicated informal learning organizations exist. Ensure these programs leverage the qualities of informal learning environments, rather than becoming an extension of school day learning.

03



Provide professional development for formal and informal educators together so that they can learn effective pedagogies, collaborate on developing activities, think holistically about STEM education, and work to integrate the learning that occurs in both settings. Encourage educators in both settings to construct sustained and connected learning sequences across settings around shared STEM outcomes.

<sup>8</sup> Bevan, B. with Dillon, J., Hein, G.E., Macdonald, M., Michalchik, V., Miller, D., Root, D., Rudder, L., Xanthoudaki, M., & Yoon, S. (2010). Making science matter: Collaborations between informal science education organizations and schools. Washington, DC: Center for Advancement of Informal Science Education (CAISE).

<sup>9</sup> National Research Council. (2009). Learning science in informal environments: People, places, and pursuits. Washington, DC: The National Academies Press.

## CURRENT PRACTICES IN THAILAND



Thai stakeholders recognize that informal and formal learning environments have a complementary role. They understand that a robust informal STEM learning program can support and promote learning in formal settings, and vice versa.

There are a variety of efforts to connect formal and informal STEM education in Thailand. For example, the National Science Museum and other museums offer school field trips, outreach programs, and camps to complement STEM learning that occurs in the classroom. For professional audiences, the National Science and Technology Development Agency offers teacher training that provides classroom teachers with hands-on, problem-based STEM units. This work focuses on bringing techniques from informal STEM education into the classroom, but stakeholders also note that similar programs could prepare teachers to facilitate out-of-school programs.

In the future, Thailand can continue to connect and improve the learning experiences that occur in different settings so that students who develop interest and motivation to learn STEM through informal learning experiences are supported in studying STEM further in school. As part of this work, the country can define appropriate learning outcomes for each learning environment, which will contribute to the overall shared goals for STEM education.

## EXEMPLARY PROGRAMS AND PRACTICES

Worldwide, there are many examples of successful partnerships among formal and informal learning organizations. This section provides models for programs and resources that connect school and out-of-school learning environments.

Singapore's Learning Journeys program introduces field trips into the school curriculum, creating opportunities for direct and intentional connections between school day learning and other settings. Students visit sites such as the science center, a national park, a water treatment plant, an electrical utility, or the aviation authority. Many agencies and organizations have developed experiential learning programs specifically designed for school students.

Afterschool programs can improve participants' academic performance, increase college and career readiness, develop positive character attributes, connect learners to role models, and engage families in their children's learning in meaningful ways.<sup>10</sup> The Children's Museum of Houston offers an exemplary program known as A'STEAM (Afterschool Science, Technology, Engineering, Arts, and Mathematics), which serves students in grades K–5 in Houston. The program is designed as a collaboration between the afterschool providers and the schools, so that

the STEAM program is directly connected to the school day curriculum but provides a complementary, informal learning approach.

The Teacher Institute at the Exploratorium in San Francisco, California, offers trainings for teaching inquiry-based science, professional learning communities, and mentoring between experienced and incoming participants. The Exploratorium also develops and provides free online instructions for hands-on activities that are used both in classrooms and in informal settings such as afterschool programs.

The Engineering is Elementary (EiE) program at the Museum of Science in Boston creates evidence-based, rigorously developed STEM curriculum for both in-school and out-of-school learning environments focusing on real-world engineering challenges. All EiE materials engage learners in the engineering design process, allowing learning that happens in and out of school to reinforce and complement each other.

**STRENGTHEN PARTNERSHIPS  
WITH SCHOOLS**

<sup>10</sup> National Research Council. (2015). Identifying and supporting productive STEM programs in out-of-school settings. Washington, DC: The National Academies Press.








## 04 STRENGTHEN PARTNERSHIPS WITH UNIVERSITIES AND INDUSTRY

*Develop and strengthen partnerships among educational institutions, universities, and businesses, leveraging STEM expertise and resources across Thailand.*

The implementation of the Thailand 4.0 policy creates an opportunity to develop and strengthen partnerships among informal learning institutions such as museums, libraries, research institutions such as universities, and companies whose work (or workforce) relates to STEM. Partnerships among organizations in the education and business sectors could accomplish diverse goals, including introducing Thais of all ages to STEM professionals and current STEM research and development, promoting awareness of STEM career opportunities among young people and their families, improving scientists' communication skills, establishing science as an integral part of the national identity, and uniting Thai people in working together to improve the quality of life in Thailand. To build on their interest and develop a STEM identity, youth need to be aware of opportunities to study and pursue a career in STEM. They also need to see and meet people like themselves who can serve as role models, and feel that universities and industries would welcome their participation and benefit from their cultural backgrounds and perspectives. This can be accomplished by creating programs that allow Thai youth and families to interact directly with STEM professionals and researchers in different settings.

### RECOMMENDATION AND STRATEGIES

- 01**  Establish universities as resources and partners of informal STEM education organizations. Develop programs and collaborations that can provide opportunities for university-level STEM students to gain science communication skills by interacting with younger learners, and that introduce younger students to older role models and mentors, so that they can envision the possibility of studying STEM themselves in the future.
- 02**  Ensure that these programs provide opportunities for students to relate to and identify with role models and mentors. This is particularly important for students from ethnic, religious, and linguistic minority groups.
- 03**  Encourage private-public partnerships that bring in industry as a stakeholder in informal and lifelong STEM learning. These partnerships can lay the groundwork for building a skilled STEM workforce, and related programs can demonstrate STEM career pathways to students and parents.
- 04**  Create a national network of museums, universities, industries, and other allied organizations that will collaboratively develop STEM educational materials and professional resources, implement signature programs that foster widespread interest in learning STEM, build learners' senses of identity and self-efficacy related to STEM, and indicate pathways to study STEM or pursue a STEM career.
- 05**  Provide additional (disproportionate) resources to efforts associated with engaging youth from non-dominant communities within Thailand in order to better ensure their participation and achievement in STEM education.

## CURRENT PRACTICES IN THAILAND



Thailand's universities are already engaged in public outreach activities on both a regional and national level, while Thailand's museums and other informal learning organizations offer a variety of programs to engage public audiences in learning about STEM. Supporting partnerships among institutions with high-quality STEM programming is a promising direction for Thailand because it builds on existing relationships, leverages complementary expertise, and further develops existing STEM research and learning ecosystems.

Science Square, the National Science Museum's satellite location in central Bangkok, partners with nearby Chulalongkorn University to offer an elective course that teaches undergraduate students about project-based learning and outreach using the museum's Maker Space. In another example, the Thailand Children's University program brings youth to university campuses across the country to engage in science learning and scientific research alongside university students and faculty. Finally, the Natural History Museum at Khon Kaen University supports university research, student internships and coursework, and public engagement in STEM. Through the regular participation of university students and faculty, these programs demonstrate a pathway from informal learning opportunities to studying STEM and pursuing STEM careers.

In sum, the current practices in Thailand already have a good start on meeting this need, and many partnerships already exist. By making these efforts more widespread across the country, and coordinating the work across educational, research, and business sectors, Thailand can further leverage existing resources and expertise toward the common goal of improving STEM education for all.

**STRENGTHEN PARTNERSHIPS  
WITH UNIVERSITIES  
AND INDUSTRY**

## EXEMPLARY PROGRAMS AND PRACTICES

Globally, there are numerous programs that connect research institutions and informal learning organizations. This section offers examples that are similar to current partnerships that exist in Thailand and therefore demonstrate the potential in further growing these efforts, as well as examples of national networks that can support local collaborations.

In the United States, Center of Science and Industry (COSI) and Ohio State University created a Center of Science where research, science, and university outreach are embedded into public, student, and family experiences at the museum. The university supports a variety of programs at the museum such as working STEM research laboratories, special events that bring STEM professionals to the museum to share their work, regular presentations by graduate and undergraduate students, interactive video conferencing, and public television production.

The participation of industry can help young people and families to envision a range of STEM-related careers and understand the importance of STEM in society and the economy. The Toyota Kaikan plant at the company's headquarters in Japan allows school visitors and the general public to visit the car assembly area and explore a museum focused on automobile manufacturing. The multinational company BP encourages employees to volunteer as mentors in their communities, with a particular focus on working with girls and underrepresented minorities. There are also opportunities to work with creative industries to offer STEAM learning experiences. For example, the Museum of Science in Boston has partnered with both Lucasfilm and Pixar Animation Studios to create exhibitions exploring the science of movies and filmmaking.

Trinity College's Science Gallery in Dublin creates exhibitions and events that draw on the diverse expertise of scientists, researchers, students, artists, designers, inventors, creative thinkers, and entrepreneurs to inspire young people to take on the world's biggest challenges. The gallery is designed for young people age, 15–25, and focuses on creating STEAM experiences that foster conversations and social connections among participants. Science Gallery International brings this model to universities around the world, including London, Melbourne, Bengaluru, Venice, and Detroit.

Professional networks can facilitate partnerships among informal learning organizations, universities, and industries. In the United States, several national networks offer complementary strategies and resources for bringing STEM experts into informal learning environments. The STEM Ecosystems Initiative supports cross-sector collaborations in communities across the United States. The National Informal STEM Education Network (NISE Net) creates STEM educational materials and professional development resources, and facilitates partnerships between museums and scientists. The Portal to the Public Network (PoPNet) provides training modules for STEM professionals to help them share their work with public audiences. Finally, the National Girls Collaborative Project provides access to resources and professional development for educators. Similar professional learning communities and networks can be established in Thailand to promote STEM education and leverage existing knowledge and resources.



## 05 PROMOTE PUBLIC AWARENESS AND PARTICIPATION THROUGH EVENTS AND MEDIA

*Utilize a strategic combination of proven and innovative public media, large-scale events, and online educational materials to recruit and engage Thai people of all ages, in all parts of the country, in STEM learning.*

Thai stakeholders agree that high-profile STEM events—supported by well-respected public figures and STEM professionals, and promoted through traditional and digital media—can help increase interest and positive attitudes toward STEM across Thailand. People can participate in these events in a variety of ways: as event exhibitors, competitors, and coaches; as spectators and followers; and as media consumers and creators. Planned and implemented in an integrated way, events, competitions, and media could help Thais of all ages become aware of opportunities to participate in STEM learning and develop positive attitudes toward STEM for themselves, their families, and their communities. This awareness could in turn encourage lifelong learning in STEM, foster widespread scientific literacy, and build a broad base of support for STEM across sectors.

Thai stakeholders see continuing value in traditional mass media such as television and radio given their ability to reach wide audiences across the country. They also note that social media, content sharing sites and other platforms are important new ways for STEM educators and researchers to reach broad and diverse audiences. Finally, they suggest that as internet access becomes reliable in more and more communities, online activities and virtual experiences can be designed to engage more people with informal STEM learning.

## RECOMMENDATION AND STRATEGIES

01



Support a set of signature informal STEM education events promoted by senior government officials and other respected figures and institutions in Thai society to generate widespread awareness and participation in informal STEM learning. These events should include existing successful initiatives, as well as new ones designed to appeal to different audiences while also taking into account the histories of places, local practices, and the people of specific regions.

02



Publicize these signature events widely and build on the excitement they generate. Create social media campaigns and public service announcements highlighting informal STEM learning opportunities and events and encourage media coverage. Such campaigns may be connected to other aspects of popular culture in Thailand. They should also feature the wide variety of ways informal STEM learning happens and show how local knowledge is essential to STEM.

03



As internet access becomes more widespread across Thailand, explore the potential for online and digital learning experiences to provide new types of STEM learning experiences, and to connect learners to each other and to STEM role models. In addition, explore the potential for connected learning and transmedia programs, which blend in-person and online learning.

04



Continue to share STEM content through mass media platforms such as television, radio, posters in public transportation, and billboards. Such presentations can increase awareness of informal STEM learning opportunities to audiences without internet access.

## CURRENT PRACTICES IN THAILAND



PROMOTE PUBLIC AWARENESS AND PARTICIPATION THROUGH EVENTS AND MEDIA

Thailand hosts a number of national STEM fairs, festivals, and competitions that generate high attendance and positive publicity for STEM. The National Science and Technology Fair is an annual event that promotes awareness of STEM research and development in Thailand and is attended by over one million people each year. The Maker Faire Bangkok and Young Makers Contest, presented by Chevron Enjoy Science in coordination with the Thai government, provides a family-friendly mix of displays, workshops, contests, and activities celebrating invention, creativity, and local wisdom. Although these national events are well attended, Thai people who live in remote areas of the country are less likely to participate in them. To address this disparity, the Ministry of Science and Technology recently established a task force focused on science inspiration to identify ways to increase participation in existing national events and to utilize media to increase awareness and participation in STEM learning.

Thailand's informal educational programming includes educational television, radio, and other traditional media for lifelong learning. For example, the National Science Museum partners with media production companies to create educational public television shows designed for children. Thais are enthusiastic users of social media and digital games, suggesting that these media could also be used to promote informal STEM education in Thailand.

Informal educators in Thailand recognize the potential to engage Thais in informal STEM learning online, as internet access improves in all areas of the country. For example, the National Science Museum is considering online exhibits as part of the new Futurium facility. The Ministry of Science and Technology has also established a task force focused on online learning in informal STEM education that could identify strategies to promote and facilitate lifelong learning through media and the internet.

In sum, Thailand has a well-established tradition of large STEM events and competitions and mass media products that generate excitement, interest, and awareness of STEM. The country is already considering a variety of strategies to build on and expand participation in these activities. As internet access increases across the country, and as more Thai education occurs online and via digital media, there will be opportunities to develop new approaches to engage youth and families and connect the STEM learning that occurs in different settings.

## EXEMPLARY PROGRAMS AND PRACTICES

With the continuing improvement of internet access across Thailand, digital and networked technologies will play an increasingly important role in engaging more people in equitable informal STEM learning opportunities. These activities may be designed as an integral part of national events and mass media, or they may provide a complementary type of learning experience.

Connected learning integrates new technologies into learning experiences and brings geographically distant learners, educators, and mentors together in physical and online spaces.<sup>11</sup> For example, the Learning Labs in Libraries and Museums initiative in the United States created physical and digital STEAM learning spaces that allow teens to pursue personal interests with support from friends and adult mentors, using a combination of digital media and traditional tools to link their learning to schoolwork, career pathways, or civic engagement projects.<sup>12</sup>

Some projects take a blended or transmedia approach to informal STEM education, creating opportunities for learning that combine or extend across different settings and media. For example, the SciGirls educational television series, created by Twin Cities Public Television, is supported by a website with online games and a national educational outreach program for elementary and middle school children. The television episodes, online materials, and hands-on curriculums are designed to encourage girls to pursue STEM careers.

11 Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., Schor, J., Sefton-Green, J. & Watkins, S.C. (2013). Connected learning: An agenda for research and design. Irvine, CA: Digital Media and Learning Research Hub.  
12 Association of Science-Technology Centers and Urban Libraries Council. (2014). Learning Labs in libraries and museums: Transformative spaces for teens. Washington, DC: Association of Science-Technology Centers and Urban Libraries Council.








## 06 BUILD CAPACITY AND INFRASTRUCTURE

*Invest strategically to build Thailand's capacity for informal STEM education through professional development and a competitive grant funding program.*

Stakeholders suggest two areas for strategic investment in informal STEM education that would help Thailand further leverage the existing infrastructure of informal learning organizations and professionals. Firstly, a strategic effort to develop and build capacity in evidence-based practices, with a particular focus on program evaluation and research, would help to promote collective learning and to ensure programs are meeting national goals. Secondly, a competitive grant making program could generate and evaluate innovative new programs and scale up existing successful programs to increase their reach and impact.

### RECOMMENDATION AND STRATEGIES

-  01 Articulate distinct goals for informal STEM learning in Thailand within the larger STEM educational system. Assess Thailand's existing informal STEM education programs in a systematic way in order to determine where programs are meeting national goals and where there are gaps, and to identify successful localized programs that could be replicated and adapted to local contexts nationwide. Use this information to assign priority areas for new investment in informal STEM education, such as those recommended in this policy brief.
-  02 Provide widespread professional development to build Thailand's capacity for program planning, development, and evaluation in the field of informal STEM education, and to grow a professional culture that uses evidence to continually improve informal learning programs. In tandem, develop a research program that establishes and contributes to the Thai knowledge base related to learning in informal settings. This strategy may include identifying entities to oversee research and evaluation work across all regions.
-  03 Consider whether and how a competitive grant funding program might complement other funding mechanisms to accomplish national goals. Compare programs in the European Union, the United States, and other areas of the world to identify a grant funding model that will be appropriate for Thailand. In the event that such a program is established, ensure that it advances best practices in development, implementation, evaluation, and knowledge-building. Allocate funding to programs that serve non-dominant communities across Thailand, in order to address inequities in the STEM education system.
-  04 Create a central online repository for informal STEM educational materials—including curricula, research and evaluation reports, and other essential information—to promote the dissemination of resources, knowledge, and evidence-based practices across Thailand. Consider launching an open education resource initiative focused on tools for professional learning.
-  05 Establish necessary management systems to carry out all six recommendations in this policy brief in ways that facilitate efficient and effective implementation.



## CURRENT PRACTICES IN THAILAND



### BUILD CAPACITY AND INFRASTRUCTURE

Stakeholders report that the distribution of informal STEM education efforts across multiple government agencies in Thailand creates a broad support base and permits contributions from professionals with diverse expertise. Thai educators and administrators share a common definition of STEM, largely agree upon the role of informal STEM education, and are aware of trends and best practices in informal STEM education worldwide. Among practitioners, there is also widespread agreement on key outcomes for informal STEM education.

Thai stakeholders identify a need for professional development to support the use of evidence-based practices in informal STEM education and to build capacity in research and program evaluation. This professional development would help organizations and practitioners identify learning goals that are appropriate for informal environments, gain a better understanding of different measures for examining impact, and establish evaluation as a regular part of program development and implementation. Some important and useful evaluation work is already taking place in Thailand.

For example, the National Science Museum evaluates the impact of museum visits and individual programs, and has done research on strategies that facilitators can use to encourage active learning by Thai visitors.<sup>13</sup>

Stakeholders also identify a need for funding to support the creation of innovative new informal STEM programs, and to replicate existing successful programs in more areas of the country. They suggest that a competitive grant funding program could allow new program ideas to emerge and be tested, and could encourage and support the participation of additional organizations in furthering informal STEM learning across all regions of Thailand.

Overall, Thailand has a diverse program of informal STEM education. Stakeholders agree that with widespread professional development and additional capacity to develop, evaluate, and implement informal STEM education, Thailand would be able to expand on global successes and adapt them to the Thai context. The country would also have the necessary tools to develop innovative new programs in communities across Thailand and to replicate successful programs nationwide.

## EXEMPLARY PROGRAMS AND PRACTICES

In the United States, many large science museums have in-house staff dedicated to researching informal STEM learning and evaluating programs. These departments are led by experts in learning theory, research, and evaluation, who also have substantial practical experience in informal learning settings. Building on this expertise, the Museum of Science in Boston is leading the multi-organization Collaboration for Ongoing Visitor Experience Studies (COVES), which creates evaluation tools that are used across many different museums, and then collectively analyzes and interprets the information. COVES helps individual organizations perform cost-effective evaluation and to compare their results with others.

In many areas of the world, government agencies and foundations provide competitive programs that grant funds for informal STEM education initiatives. For example, in the United States, the National Science Foundation supports the Advancing Informal STEM Learning (AISL) program, which is designed to promote innovation and impact, scale up successful programs, and contribute to the knowledge base about learning in informal environments. AISL funds pilot and feasibility studies, research in service to practice, innovations in development, broad implementation, and conferences. The program also supports a resource center, the Center for Advancement of Informal Science Education (CAISE), which serves as a repository for evaluation reports and other documents associated with informal STEM education projects ([www.informalscience.org](http://www.informalscience.org)). In some countries, public-private partnerships enhance capacity by integrating funding streams from government agencies, corporations, and private foundations.

### BUILD CAPACITY AND INFRASTRUCTURE

<sup>13</sup> Karnolpattana, S., Chen, G., Sonchaeng, P., Wilkinsen, C., Wiley, N., & Bullitude, K. (2015). Thai visitors' expectations and experiences of explainer interaction within a science museum context. *Public Understanding of Science* 24(1), 69–85.

## CONCLUSION – INFORMAL STEM EDUCATION POLICY OUTCOMES

These six recommendations support the objectives of Thailand 4.0 and offer strategies to develop broad competency in STEM for all Thai people as well as a specialized STEM workforce. Implementing these recommendations will involve more of the youth of the country, along with their families and communities, in learning about STEM and its relevance to their lives. Supporting youth identification and interest in STEM, and helping young people see a path forward in their own lives and in their communities in STEM-related fields will help to create an inclusive and equitable society that realizes the full potential of all its members. By connecting STEM to families' and communities' expertise and histories, Thailand can build economic prosperity and a culturally-thriving society by drawing on the innovation, technology, and creativity that have always existed in rich and diverse forms across the country. As the offerings of informal STEM education efforts are implemented broadly in ways that complement formal education, Thailand will be better positioned to create new solutions to global challenges.



## CONCLUSION – INFORMAL STEM EDUCATION POLICY OUTCOMES

# INFORMAL STEM EDUCATION POLICY



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