INSTITUTE FOR Learning Innovation

# Towards a 21ST Century Approach to Science Education Policy

**(with a particular focus on the vital role that informal/free-choice science learning plays in promoting the well-being of people and the planet)**

Leading science educators from 9 South and Southeastern Asian countries and the U.S. met for three days in Kuala Lumpur, Malaysia (October 4-6, 2017) in an effort to rethink and re-envision science education in the 21st Century. The attendees of this U.S. National Science Foundation-funded international conference reaffirmed the G8-Science Academies Joint Statement (2011) that education in science must be targeted not only to future scientists, engineers and other specialists in government and industry, but also to the general public, including school-aged children and adults. The attendees at the October meeting further asserted that public science education should be relevant for all individuals (for more detail on the meeting, see Appendices A-C: Evaluation Report, Conference Agenda and Participants).

Attendees drafted and unanimously approved the following national science education policy goals:

## GOALS for a 21ST CENTURY APPROACH to SCIENCE EDUCATION POLICY

1. Build awareness and interest in the importance of lifelong science learning and participation.
2. Share examples of evidence-based practice and seek opportunities for collaboration and cooperation nationally and internationally.
3. Leverage existing formal, informal/free-choice, business/industry and family/community assets and structures to support lifelong science learning and participation.
4. Ensure personal, cultural and societal/global relevance by connecting science to people's lives and providing equal access for all.

As outlined in the third goal, the group declared it imperative that all nations move towards a four-pronged approach to science education; one that equally engages each of four critical educational sectors or pillars – formal; informal/free-choice; business/industry; and, family/community. Each of the four sectors / pillars need to work together in order to create a seamless, integrated public education that ensures equitable access, relevant content and sustainable programs and activities. The attendees asserted that bringing science into people's daily lives and helping them understand and value science is essential for simultaneously supporting human well-being, and protecting and restoring the natural world.

A major focus of the meeting, and thus this statement, was the key role that informal/free-choice science learning plays for supporting lifelong public understanding and appreciation of science. The critical contributions this key educational sector make are often under-appreciated and under-supported within national science education policy. The informal/free-choice science education community has demonstrated an ability to innovatively support the public's learning in ways that are both relevant to their basic needs, as well as to the health of the planet. Attendees explored ways to better coordinate and support the actions of this vital sector in order to weave access to science learning throughout all of the learning spaces of societies and the activities of daily life.

## What is Informal/Free-Choice Science Learning?

Informal/free-choice science learning is the science learning that occurs outside of the prescribed, top-down, curriculum-driven environment of the school classroom. This form of learning typically occurs while people go about their daily lives when surfing the Internet, watching television, reading a newspaper or book, conferring with friends and colleagues, joining a club, or visiting museums or other cultural institutions.



Significant evidence exists to show that experiences in informal/free-choice settings are as essential, if not more important to public understanding and interest in science, than schooling (Falk, et al., 2016; Falk & Needham, 2013; Falk, Pattison, Meir & Bibas, 2018; NRC, 2015). For example, hundreds of millions of people of all ages and backgrounds visit science centers and natural history museums across South and Southeast Asia and the U.S., as well as in other regions of the world. These institutions make science accessible to a broad range of people in innovative, engaging and enjoyable ways and thus play a critical role in supporting the lifelong science learning of the public (NRC, 2009). Like all educational resources though, informal/ free-choice learning institutions and organizations have weaknesses and constraints. By integrating and leveraging the capabilities of this key sector, along with those afforded by the formal; business/industry; and, family/community sectors it should be possible to ensure equitable access to quality science learning opportunities for more people, more of the time.

## Changing Realities of Science Learning in the 21st Century

Inventing new models for public science education in the twenty-first century requires addressing realities and challenges unlike those faced by the creators of the current, school-focused public education system. In the twenty-first century, public science education needs to be fully focused on meeting the lifelong science learning needs of *all* people, at *all* stages of life, *wherever* a person is and *whenever* such a need arises. For example, a twenty-first century system for lifelong public science learning must have the capacity to support the ever-changing nature of science, across every possible topic area and the ability to empower citizens attempting to address every type of science challenge, need or context. The future public science education system will need to be first and foremost learner-centered which the primary goal of serving the real-life science learning needs, realities and motivations of all people 24-7, across an entire lifespan. By contrast, the current system overly privileges past science, those already advantaged and/or those believed to have the potential to one day become

science professionals. A true, universally accessible public science learning system does not currently exist anywhere in the world, but pieces exist in every country. What also exists is a growing appreciation for what such a system needs to look like and how to create it. The key to creating such a system is thinking systemically, outside of the current educational box. Meeting attendees recognized that no single pathway exists to support this vision; each nation and community must forge their own new and systemic vision of lifelong public science learning.

## Call to Action

As representatives of the global science education community, we invite governments, industry, funders, institutions of formal and informal education, members of health and civic organizations, and local communities, to come together to cultivate a world in which all people, young and old, have equitable opportunities to engage in meaningful science learning opportunities. To achieve this future, we encourage adequate and equitable funding among each of the four educational sectors and creative collaborations, both within and across nations. We urge policy makers and funders to move beyond Industrial-Age, top-down, one-size-fits-all approaches to science learning that overly depend upon schools and universities, towards approaches that embrace the more distributed, synergistic, personalized, just-in-time, global realities of the lifelong, life-wide and life-deep learning of the twenty-first century. And we urge all nations to share relevant examples of successful evidence-based practice and proactively seek opportunities for meaningful collaboration and cooperation.

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# APPENDIX A

# Meeting Evaluation

**Final Evaluation Report:**

**International Conference: The integration of Science Centres with Natural History Museums for Imparting Informal Education**

Award 1724213

Judith Koke, MMst

Introduction

The catalyst for this International Meeting was a growing awareness globally of the increasing importance of a science literate and engaged public. The project had three major goals:

1. To examine the opportunities, challenges, barriers and infrastructure needed to build a more systemic approach to 21st century public science education.
2. To examine the opportunities, challenges and barriers to making informal/free-choice science education institutions both more central and more relevant to the 21st century publics of all ages, both culturally and personally.
3. Foster intra- and inter-national collaborations in the service of creating new, more self-sustaining models for supporting the public's science learning.

To deliver on these goals, with primary support of the U.S. National Science Foundation a meeting was convened in Kuala Lumpur. With collaboration from the Pakistan National Science Foundation and the Petrosains Science Centre, Malaysia the Institute for Learning Innovation facilitated a meeting that brought together an invitation-only group of 35 ministerial level policy makers, university leaders, government officials and science centre and natural history administrators from 9 South Asian countries plus the U.S. The meeting was designed to explore the need and potential methods to enhance national capabilities for science learning in each of the represented countries. The meeting included official welcomes, an initial presentation, and two days of large and small group discussions - both in cross-national as well as within-national groups. Prior to the start of meeting, participants were asked to describe what they considered an example of an exemplary science learning effort from their country. At the conclusion of the meeting, participants were asked to reflect on what they learned about science education from the meeting and their professional commitments to furthering science learning in their country and region. Six months later, participants were contacted a third and final time, to explore what changes had occurred in their perceptions of science learning generally, how they might influence science learning in their nation, and whether ongoing collaborative relationships had been developed as an outcome of the meeting. This report is the summary of those findings.

**Methods** – Conference

The participants in this International Conference were key ministerial level policy makers, university leaders, government officials and science centre and natural history leaders from South Asia, the western part of South East Asia and the United States; specifically, leaders from the following ten countries: Pakistan, India, Bangladesh Nepal, Sri Lanka, Malaysia, Singapore, Thailand, Indonesia and the United States. A total of 40 participants were invited to participate, 4 individuals per country, 35 of whom ultimately attended (see Appendix A).

The conference was designed to explore the need to enhance the national capabilities for science learning in each of the represented countries. Welcoming remarks were made on the first evening by two dignitaries: Professor Datuk Dr. Mathlan Othman, Director, International Council for Sciences, former Director of the United Nations Office for Outer Space Affairs and former Director General of the Malaysian National Space Agency and the Honorable Kamala Shirin Lakhdhir, U.S. Ambassador to Malaysia. At the start of the full first day of the meeting project PIs Falk and Dierking laid out an initial framing of the topic, specifically that the public's science learning is supported by three key "pillars": the formal education sector, business and industry and the broad and multidimensional informal/free-choice learning sector, e.g., places like science centres, museums, zoos, science events and after school programs for children, government and citizen groups involved with environmental and health-related issues, from media such as science-related television programming as well as the educational efforts of a wide variety of other science-related groups and organizations. A key message of their presentation was that despite the almost total focus internationally on just one of these pillars, the formal education system, as much if not more of the long-term science learning benefits is due to the efforts of the other two pillars, in particular, the informal/free-choice learning pillar. Interestingly, over the course of group discussion, a fourth "pillar" of science education was proposed, and agreed to by the group: the vital science education role that families and communities play. The focus of the rest of the meeting was on exploring how, on both a national and international level public science education policy could work to better integrate and synergize these four key parts of public science education equation. A summary of the meeting agenda is included as Appendix B.

A major outcome of the meeting was the development of a group-initiated policy statement: "GOALS for a 21ST CENTURY APPROACH to SCIENCE EDUCATION POLICY." It is significant to note that the idea of creating a science education policy statement as a meeting outcome was not part of the original meeting plan but rather arose from within the group itself. The meeting attendees unanimously approved the following the statement.

GOALS for a 21ST CENTURY APPROACH to SCIENCE EDUCATION POLICY

- Build awareness and interest in the importance of lifelong science learning and participation.
- Share examples of evidence-based practice and seek opportunities for collaboration and cooperation nationally and internationally.
- Leverage existing formal, informal/free-choice, business/industry and family/community assets and structures.
- Ensure personal, cultural and societal/global relevance by connecting science to people's lives and providing equal access for all.

**Methods:** Conference Evaluation

As outlined above the goals of this endeavor were:

1. To examine the opportunities, challenges, barriers and infrastructure needed to build a more systemic approach to 21st century public science education.
2. To examine the opportunities, challenges and barriers to making informal/free-choice science education institutions both more central and more relevant to the 21st century publics of all ages, both culturally and personally.
3. Foster intra- and inter-national collaborations in the service of creating new, more self-sustaining models for supporting the public's science learning.

To assess the impact of participation in the conference, formal data were collected at three points:

A. Prior to participating in the conference
B. At the conclusion of the conference
C. 6 months following participation in the conference.

A. Pre-Conference

Prior to attending the meeting, all participants were asked to read a set of articles related to public science education. Each participant was also asked to complete a short assignment prior to arriving at the meeting. Participants were asked to write-up, in one page or less, a description of one example of an exemplary science popularization educational effort in their country outlining the main goal(s), the key educational approaches/ strategies employed, which audience the program served; and finally, how these efforts were evaluated to provide evidence of success. These examples served as a baseline indication of how participants viewed "exemplary" science education prior to the meeting and, importantly, whether they currently considered cross-sector collaboration and integration critical to the process.

One conference participant, Dr. Aceng Ruyani, co-wrote a chapter in the 2017 book *Preparing informal science educators: Perspectives from science communication and education*[1] with Catherine Matthews (University of North Carolina, NSF funded Project HERPS – Herpetology Education in rural Places and Spaces). In the chapter Ruyani and Matthews explain that opportunities for free-choice learning opportunities through out-of-school activities are limited to non-existent in Indonesia. Informal learning groups such as scouts or clubs are generally not available, and citizens have limited experience with nature. Thus, while the Indonesian government has prioritized environmental education, opportunities to engage in environmental learning are scare. He suggests that informal science learning opportunities could rally the Indonesian people before their natural resources cease to exist.

B. End-of-Conference

[1] Ruyani, A. & Matthews, C.E. (2017). A comparative look at informal science education and environmental education in Bengkulu Province, Indonesia and North Carolina. In P. Patrick (Ed,) Preparing informal science educators: Perspectives from science communication and education (pp. 387-418). Cham, Switzerland: Springer. ISBN 978-3319503967.

At the end of the last day of the meeting, conference participants were requested to complete a one to two-page response to three questions:

1. What is your key learning(s) from the conference?
2. With whom do you believe it is important to connect to after leaving this conference?
3. What do you plan to do to further the popularization of science learning and to move our jointly developed "GOALS for a 21ST CENTURY APPROACH to SCIENCE EDUCATION POLICY" forward?

C. Six Month Post-Conference

Six months after the conclusion of the meeting each participant was re-contacted by email and asked to complete a short, 12-item questionnaire that explored their learning from the meeting, actions taken post-meeting and to determine if any ongoing communication and/or networking relevant to the meeting's goals had taken place since the end of the meeting.

**Findings**

**A. Pre-participation Exemplars – Indications of Current Practices**

Each participant brought examples of programs offered by their institution. The examples brought to the meeting ranged broadly from Science Olympiads to Science programs for high school students and 3 Citizen Science projects. The Asian programs were strongly situated in the offering organization. There were almost no examples of collaborations between organizations, industries or communities present in these initial examples of "exemplary programs." Most were either didactic presentations or competitions, few offered collaborative, project-based learning. Very little evaluation had been performed. By contrast, the "exemplary programs" submitted by the American contingent and the UNESCO representative outlined more collaborative projects involving media outlets, school districts, and community groups.

**B. At End of Conference**

Almost unanimously, the conference participants describe their key learning as a new, or renewed understanding of the importance of informal science learning as a vehicle for popularizing since understandings across their populations, and as a complement to formal science education efforts.

In descending order of frequency, key learnings were identified as:

- The importance of free-choice or informal learning in disseminating science concepts broadly
- The importance of national approach to/new policies to support science learning that seeks to integrate both informal and formal education
- The importance of an integrated ecosystem of science learning – a) across pillars (formal education, industry, family/community, informal learning environments), and b) across a larger scale, either nationally or globally
- The importance of synergy among different organizations
- New vehicles or programs available to employ in science learning and the popularization of science
- The refocus of education leaders and funders to consider learning rather than instruction
- The wealth of existing research to support this work

- The power of collaboration to generate productive ideas

Participants left the conference emboldened to reach out to important influencers in their regions. They described the intention to reach out to leaders in government and educational organizations, as well as policy and budget directors. Individuals spoke of bringing new knowledge back to their organizations and teams, but also to potential partners outside their broader community of education leaders. One individual spoke of sharing key concepts on a weekly radio show they host, another of building a city-wide community of practice to support capacity building.

When asked what they planned to contribute to the popularization of science learning, participants indicated a strong desire to:

- influence policies and budgets
- share conference research and case study examples
- perform more evaluation and research on existing programs
- engage organization boards and leaders in this discussion
- create new programs with broader reach and impact
- collaborate with like-minded individuals in other organizations
- build support of a local science center
- reach out nationally and internationally

It is clear the meeting generated energy and renewed participants' enthusiasm to work in (or influence) their country's national agenda and practice of science learning. Participants were able to identify key challenges and barriers to success and recognized the strength of collaborative solution making. The conference supported the early development of strategies – both individual and collaborative. It provided the opportunity to establish important relationships across sectors and nations of professionals engaged in this field.

Although not part of the formal evaluation, the development of GOALS for a 21$^{ST}$ CENTURY APPROACH to SCIENCE EDUCATION POLICY statement itself is an important data point. Both the content of the policy statement as well as the fact that the impetus for creating such a statement arose spontaneously from the participants rather than from the organizers can be taken as strong evidence that the meeting successfully achieved its three stated goals of building a more systemic view of public science education; increasing the perceived importance and relevance of informal/free-choice learning institutions to fostering public science education; and building inter- and intra-national support for these ideas.

**Six Months Post Conference**

Six months after the meeting a 12-item survey (Appendix C) was emailed to each of the 35 Conference attendees, 17 completed the survey (a 49% responses rate). At least one response was received from each of the ten participating countries. Below are summaries and representative responses for each of the 12 questions asked.

Question #1: Did participation in this conference in any way change or enhance your perspectives on the popularization of science and how to advance public engagement and understanding of science in your country? Please explain.

All but one respondent answered this question in the affirmative. Many indicated a heighten understanding of the role of informal science learning in a national agenda. In addition to learning about existing research, and new approaches, a key learning was the importance of reaching out to industry and business.

> It was specifically useful in enhancing my understanding on new models for supporting the public's science education through the use of informal/free-choice learning assets (Thailand).

> I found that the addition of the "workplace: business and industry" pillar of science learning was an important perspective to consider when thinking about the popularization of science and advancing public engagement and understanding. In addition listening to the diverse perspectives of international colleagues was quite interesting and informative. (Singapore)

Question #2: Did participation in this conference in any way support your on-going efforts to popularize science and advance public engagement and understanding of science in your country? Please explain.

Again, the responses to this question were overwhelmingly positive. Respondents spoke of engaging new publics in existing and new programs, working with new partners and funders, having an increased sense of commitment to the work of informal science learning, and the ability to ground their conversations in research and exemplar practices.

> Yes. Based on the deliberations of the conference the issue was raised by the undersigned in a Conference of Heads of the science museums and science centres in India in Dec 2017 and a resolution was passed that the role of such informal science learning institutions should be brought to the notice of policy makers. A letter has been sent to the Chairman of the committee who is engaged in making the new education Policy of the Govt. (India)

> I think that all who work in the world of science engagement are struggling to find the best way to connect with informal, formal, families and communities and businesses. Having Falk and Dierking set up the conversation grounded in research and practices, helped expand my thinking. (Singapore)

Question #3: Do you feel there has been a change in your approach to the popularization of science and how to advance public engagement and understanding of science since the conference? Please explain.

Approximately one quarter of respondents felt there had not been a change in their approach, but that the power of their convictions had increased. The majority of respondents felt their approach had changed, and, in some situations, with success.

> Yes, in thinking about the relative importance of informal to formal environments for the learning of science, in contrast to the relative amount of resources allocated to them. (USA)

> I tried to give some inputs to several stakeholders. One of them is museum communities or science centers. I suggested to use a lot of resources for the above purposes i.e. higher education institution involvement and family. Some of science centers/museums could provide some programs related both stakeholders. So I felt a change of the approach on science popularization. (Pakistan)

> Being a hardcore researcher, but also involved in formal teaching I only used lecturing and demonstrations in the class. My approach now is to also use other activities as well. (Malaysia)

Question #4: Was the idea of the "Four Pillars[2]" of science public engagement and understanding of science useful to you in your work? Please explain.

[2] Four Pillars: formal education, informal/free choice learning, business and industry, community and family

All respondents felt the concept of the Four Pillars was very important and useful. Most expressed having ignored one of the pillars previously – often the business and industry sector. It is clear that this concept is shaping the participant's practices.

> Yes. I generally work with 3 of the 4 pillars (families/community/formal and informal education) but the business pillar is really an important pillar that I was not as tuned into. We do a lot of career focused programming for high school students and beyond and have not necessarily been partnering with industry and business beyond the fundraising needs. There is a great deal of potential in this area. (Singapore)
>
> The ideas of four pillars is extremely useful for the development of science popularization activities in short and long-term programs (India)

Question #5: Now that you've had some time to reflect, do you feel that participating in this meeting was worthwhile to you? Please explain.

One individual who travelled from the USA, and was very familiar with the concepts presented, felt the personal benefit of new connections did not outweigh the significant investment in travel time. However, each of the other respondents, including other USA participants, found the experience to be rich and worthwhile, offering new connections, skills and knowledge. The organizers of the meeting were reminded that one goal was to develop a forum for ongoing interaction, and a question arose as to how that would happen.

> Yes of course the meeting was extremely useful. it increased my knowledge, skill, confidence, network, and others positive impacts. (Pakistan)
>
> Yes, to a great extent. The participation and sharing of experiences and the presentations has helped a lot to give a new dimension to my thinking of public engagement and understanding of science through various informal learning centres. (Indonesia)

Question #6: Have you connected with any other participants since the meeting? With whom and for what reason?

Respondents have been in touch with each other and with nonparticipants identified as instrumental in assisting in the popularization of science and science learning. In looking back to the individuals or organizations that participants identified as important to contact on the last day of the conference, many of those have been reached.

> Ganigar Chen. A pop-up exhibition from my Museum went to Thailand and I connected with her about this. Dr. James Short - ideas about a potential grant. (Singapore)
>
> Malaysia, Thailand for collaborative projects and sharing of information (Bangladesh)

Question #7 and #8: Who else from your country do you think would have been important to have been invited to the meeting? Please explain. Has that person been informed about the meeting?

Respondents had a number of suggestions, particularly of additional representatives from Ministries of Education, Science or Technology. For a full list of suggested additional participants, see Appendix D. In most cases, individuals identified in question 7 had been informed about the meeting. In some cases, respondents are waiting for the final report/white paper to be distributed, before connecting the stated individual.

Question # 9 and #10: The organizers of the meeting sought to make it a highly participatory meeting. Do you feel they were successful? Please explain. Do you believe everyone felt equally involved and comfortable to speak out?

Participants found the experience to be highly interactive and participatory. As a group, they initiated the addition of two key elements of the meeting – the addition of the fourth pillar and the list of Goals for a 21st century approach to Science Education policy (see page 2)

> Yes, very much. The sessions were very interactive, and participants were totally involved in the process. Many success stories were also shared during the interactive sessions beneficial for all. (Indonesia)
>
> Yes, there was very high participation and value added from that. (Nepal)

Question #11: If the meeting organizers could do one additional thing to help advance policy related to the popularization of science and public engagement and understanding of science in your country, what would you suggest they do?

Respondents had unique suggestions – including support for using and sharing research, developing a 'position paper' to be shared with key influencers, and connecting with a broader audience, particularly government officials.

> A well-prepared strategy paper on the outcome of the conference, if sent to the respective Govt. and to us also for circulation, may help in enhancing the cause of the informal science learning institutions and more funding for such activities. (Indonesia)
>
> Perhaps develop a "toolkit of data" that provides research information and talking points to help standardize or enrich how people talk about the benefits of informal science education. (India)

Question #12: If the meeting organizers could do one additional thing to help advance policy related to the popularization of science and public engagement and understanding of science in the region, what would you suggest they do?

Respondents had numerous suggestions for this question as well, including connecting with existing professional organizations in the regions, offering more conferences in the area, as well as developing a conference inclusive of the Four Pillars. They suggested including more policy leaders and underscored the political nature of science education in this area. A number of individuals suggested a platform for exchange and networking, and ongoing dissemination of new, supportive research results. The full list of responses can be found in Appendix F.

**Implications**

As evidenced by the very positive responses, it is clear this gathering fostered deep learning and new connections; it was a valuable catalyst for international and intranational awareness and discussion of free-choice/informal learning. The group expressed that they came away with a significant number of new ideas they had learned and expressed the desire to find ways to continue learning and to access new research.

This meeting brought together individuals from not only a number of different countries/cultures, it also combined individuals from across a wide range of government and educational positions and perspectives. However, arguably because of the interactive, participatory nature of the meeting, participants uniformly said they found the meeting comfortable and expressed sincere appreciation for the ability to have their voices/opinions heard.

In reference to the project's goals, the project also appears to have been successful. First, the opportunities, challenges, barriers and infrastructure needed to build a more systemic approach to 21st century public science education were identified, and potential solutions were generated. In considering the opportunities for collaborations the group refined and redefined the four pillars, to consider building a broad base of engagement and support across all areas of society. The group identified the intensely political nature of expanding science learning into the relatively new territory of informal learning, as most countries are deeply invested in formal science learning. They strongly urged the conference organizers to produce a white paper[3] summarizing the learning and discussion that they can utilize in their own countries for garnering support and resources from their decision-makers and governments.

The project's second goal, the opportunities, challenges and barriers to making informal/free choice science education institutions both more central and more relevant to the 21st century publics of all ages, both culturally and personally, was a topic that was closely examined during the meeting. All members of the group reported an increased awareness and understanding of out-of-school learning – and could articulate the potential that such programs and investments could make to radically altering their citizenry's science engagement. Apropos of this point, the group developed the joint policy statement and as a group committed to its tenents. However, they also underscored the need to develop a set of strategies for successfully supporting these goals across the region.

During the effort to discuss cultural relevance and science learning the participants identified that each of their homelands have both diverse minority populations and significant income disparity, and that each nation deals with those issues very differently. Thus arriving at a shared solution would prove not only challenging but also would likely be unproductive. However, the conversation did converge across nations during a conversation about Natural History Museum and Science Center collaborations and a discussion of the (originally 3) pillars. It was during this discussion that the Director of the National Museum of Natural History, India suggest the addition of a 4th pillar – families and communities. This suggestion proved to be a constructive way to support the conversation about cultural relevance across culturally diverse participants, and resulted in the generation of a range of useful strategies for reaching out to diverse communities. In particular, framing the discussion around families and communities grounded the conversation in ways that allowed participants to talk about the needs of real people

[3] Note – such a White Paper was included in the original proposal for this project and is anticipated to be written by September 2018.

within authentic cultural contexts. In particular, much of the conversation focused on the needs and realities of rural and village life and focused on how to successfully and meaningfully support access to science learning for the hundreds of millions of South Asian individuals living in these settings.

The third goal was to foster intra- and inter-national collaborations in the service of creating new, more self-sustaining models for supporting the public's science learning. The follow-up survey provides evidence that this has in fact begun to happen, as demonstrated by the following three examples:

> Participation in the Malaysia meeting *contributed* to Professor Ruyani's ability to build internal and governmental support for her participation in the international NSF funded HERPS project as outlined below – as she was able to underscore the important role and value of free-choice/Informal learning in a compelling manner supported with strong data from research.
>
> A different participant from Indonesia reported that he or she connected with his/her counterparts in Singapore to initiate a collaborative program and visited the Singapore Science Centre in person.
>
> A participant from Nepal reported connecting with Mr. Irakli Khodeli of UNESCO based in Indonesia to organize science teachers' workshop on research ethics in Kathmandu.

A number of respondents suggested that the creation of some form of platform (i.e. list-serve, website) for exchange would support the ongoing activation of relationships established at the meeting and information sharing. As mentioned above, another suggestion to support this goal was the publication of conference proceedings or a White Paper to serve as support when reaching out to new colleagues and organizations to shape new collaborations.

**Recommendations**

1. Consider assisting representatives from the region in the establishment of a platform to support ongoing networking and exchange.
2. Focus on government and formal education leaders as the audience for the aforementioned White Paper to support conference participants and their allies in building support for free-choice/informal science learning.
3. This meeting underscored the potential critical role that the USA (through the NSF) can play in helping to catalyze international efforts to broaden public understanding of and engagement with science; both regionally and internationally.
4. After the dissemination of the intended White Paper, we believe interest and commitment to the important role that free-choice/informal science learning can play in building healthy and informed communities will likely be piqued. However, in the absence of sustained efforts, e.g., another conference – perhaps one that specifically includes members of business and industry – or some other kind of collaborative face-to-face or digital support mechanism, long-term change is less likely to occur.

Given the apparent success of this initial effort, some kind of follow-up effort seems both warranted and likely to be successful.

# APPENDIX B

## Meeting Agenda

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# Conference Revised Agenda

## Kuala Lumpur, October 4-6, 2017

Day One/Half Day

| | |
|---|---|
| 12:00-4:00 pm | Conference Registration |
| 4:00-5:00 pm | Conference Welcomes and Overview<br><br>Professor Dr. Mathlan Othman<br>Director, International Council for Sciences<br><br>Honorable Kamala Shirin Lakhdhir<br>U.S. Ambassador to Malaysia |
| 5:00-6:00 pm | Introductions/ Icebreaker Exercise |
| 6:00 pm | Reception and Dinner (venue TBD) |

Day Two

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|---|---|
| 9:00 -10:00 am | Falk & Dierking Presentation – Science Education in the 21st Century -- Science Learning Ecosystem and 3 "pillar" premise and current roles/affordances and constraints of informal/fcl institutions in pursuit of multiple pathways |
| 10:00 -11:00 am | Whole Group discussion[4] |
| 11:00 -11:30 am | Coffee Break |
| 11:30 -12:30pm | Small groups talk about the science learning ecosystems within their country – relative strengths and weaknesses of 4 "pillars" |
| 12:30-1:30 am | Lunch |
| 1:30-3:00 pm | Sharing of small groups & discussion |
| 3:00 - 3:30 pm | Break |
| 3:30 – 4:15 pm | Small Group by country, how could we create a science learning ecosystem that better optimizes the 4 pillars: 1) Across the life span – children and adults; 2) for STEM careers and public engagement; 3) For minorities and under-served populations; and 4) is culturally and personally relevant for all. |
| 4:15 - 5:15 pm | Quick sharing out and then Whole Group conversation about how to create a more robust science learning ecosystem that better optimizes the 3 pillars. |
| 7:00 - 9:00 pm | Dinner & Cultural Event at Petrosains Discovery Science Centre |

[4] Fourth "pillar" of science education – family and community – suggested and adopted during discussion.

Day Three

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| 8:30 am-9:00am | Whole group brainstorming about existing informal/assets. |
| 9:00 am-10:30am | Small groups talking about opportunities and challenges for significantly enhancing informal/free-choice science learning assets and insuring that synergies exist within and between sectors. |
| 10:30 -11:00 am | Coffee Break |
| 11:00 -12:00 pm | Sharing and Whole Group discussion.[5] Brainstorming about contents of a regional science education Policy Statement. |
| 12:00-1:00 pm | Lunch<br><br>Small working group drafts initial Policy Statement. |
| 1:00-2:30 pm | Presentation of draft Policy Statement. Group process to refine/revise Statement. Policy Statement ratified by Group. |
| 2:30 pm-3:00 pm | Coffee Break |
| 3:00-4:30 pm | Small Group meetings to develop plans for building a robust science learning ecosystem that includes and supports each of the 4 pillars as co-equals and follows guidelines of Policy Statement. Each group provided a template to complete. Groups organized by nation. Each nation's plans posted for others to review. |
| 4:30-5:00 pm | Next steps and Closing Remarks |
| 5:00 pm | Conference Ends |

[5] Recommendation from group to develop and endorse a regional science education policy statement.

# APPENDIX C

## Meeting Participants

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# Meeting Attendees

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| **Bangladesh** | **Professor Dr. Syed Saad Andaleeb**, (Ph.D.)<br>Vice Chancellor<br>BRAC University |
| **India** | **Mr. Samarendra Kumar**, Director,<br>National Council of Science Museums<br><br>**Ms. Naaz Rizvi**, (M.Sc.),<br>Director<br>National Museum of Natural History<br><br>**Dr. A. Senthil Vel,** Adviser<br>Ministry of Environment, Forest & Climate Change<br><br>**Dr A.K. Sahoo, (M.Sc. Ph.D., FES)**<br>Scientist 'D',<br>Botanical Survey of India, |
| **Indonesia** | **Mr. Irakli Khodeli**<br>Programme Specialist<br>Social and Human Sciences<br>UNESCO Office in Jakarta<br>Regional Science Bureau for Asia and the Pacific Cluster Office for Brunei, Indonesia, Malaysia, the Philippines and Timor-Leste<br><br>**Ms Rita Yuliarti**<br>Planning, Evaluation and Reporting Analyst<br>Taman Pintar Science Center<br><br>**Hendra Suryanto**,<br>Head of Section for Vocational and Profession Directorate of Learning and Student Affairs<br>Ministry of Research, Technology, and Higher Education<br><br>**Dr. Aceng Ruyani, MS**<br>Professor of Developmental Biology<br>Graduate School of Science Education<br>The University of Bengkulu<br>Ministry of Research, Technology, and Higher Education |
| **Malaysia** | **Tengku Nasariah Syed Ibrahim**<br>CEO<br>Petrosains Science Centre<br><br>**Mr. *Saiful* Bahri Baharom,**<br>Director of Strategic Planning & Science Advisory<br>Petrosains Science Centre<br><br>**Ms. Mismah Jimbun**<br>Director, Pusat Sains Negara,<br>National Science Centre,<br>Ministry of Science, Technology and Innovation (MOSTI)<br><br>**Mr. Robert (Todd) Hannah**<br>Environment, Science & Technology Officer<br>U.S. Embassy Kuala Lumpur |
| **Nepal** | **Er. Ganesh Shah,** President, Executive Board, Nepal Science Olympiad<br>Bagbazar, Kathmandu, Nepal<br>(*Former Minister of Science, Technology and Environment)*<br><br>**Prof. Dr. Sitaram Byahut**<br>Associate Professor,<br>Physics Department<br>Tribhuwan University<br><br>**Dr. Dinesh Raj Bhuju** (PhD)<br>Academician<br>Nepal Academy of Science and Technology |

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| **Pakistan** | **Dr. Muhammad Rafique, PhD**<br>Director General,<br>Pakistan Museum of Natural History<br><br>**ADr. Khalid Mahmood, (PhD F.R.E.S)**<br>Curator<br>Zoological Sciences Division<br>Pakistan Museum of Natural History<br><br>**Dr. Mirza Habib Ali (PhD)**<br>Director, Research Support<br>Natural Sciences Linkages Programme<br>Pakistan Science Foundation |
| **Sri Lanka** | **Hon. Susil Premajayantha**, Minister<br>Ministry of Science, Technology and Research<br><br>**Prof. Sirimali Fernando**<br>*Chair*, National Science Foundation of Sri Lanka (NSF) and<br>CEO, Coordinating Secretariat for Science, Technology and Innovation (COSTI)<br><br>**Prof. M.J.S. Wijeyaratne**<br>*(B.Sc., M.Sc., Ph.D., FI Biol, C Biol, FNASSL)*<br>Senior Professor and Chair of Zoology,<br>Department of Zoology & Environmental Management,<br>University of Kelaniya,<br><br>**Dr Sachie Panawala**<br>National Science Centre<br>and also the Focal point for STEM education at COSTI |
| **Singapore** | **AU YONG Kok Soon**<br>Senior Manager, Higher Education Policy<br>Ministry of Education, Singapore<br><br>**Ms. Anne Dhanaraj**<br>Sr. Director, Education Programmes<br>Science Centre Singapore<br><br>**Mr. Daniel Tan**<br>Senior Director for Projects and Exhibition, Science Centre Singapore |
| **Thailand** | **Dr. Pichai Sonchaeng**<br>*Director*, BUU Innopolis<br>*Founder Dean*, Faculty of Marine Technology<br>Burapha University Chanthaburi Campus<br><br>**Ms. Ganigar Chen**<br>Director, Office of Public Awareness in Science<br>National Science Museum<br><br>**Dr. Pornphan Waitayangkul**<br>President, Institute for the Promotion of Teaching Science & Technology |
| **United States** | **Mr. Jeff Rudolph**<br>Director<br>California Science Center<br>Los Angeles, CA<br><br>**Ms. Shari Rosenstein Werb**<br>Asst. Director of Education & Outreach,<br>National Museum of Natural History,<br>Smithsonian Institution<br><br>**Dr. James Short**<br>Program Director<br>Leadership and Teaching to Advance Learning<br>Carnegie Corporation of New York<br><br>**Ms. Elizabeth Christopherson**<br>Executive Director<br>Rita Allen Foundation |


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