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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 (see Appendices A & B for 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 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 Professor Dr. Mathlan Othman Director, International Council for Sciences Honorable Kamala Shirin Lakhdhir U.S. Ambassador to Malaysia
5:00-6:00 pm	Introductions/ Icebreaker Exercise
6:00 pm	Reception and Dinner (venue TBD)

Day Two

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

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 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 B

Meeting Participants

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Meeting Attendees

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

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