Center for Research on Lifelong STEM Learning

Typology for Public Engagement with Science

A Conceptual Framework

Working Paper 2

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PREFACE

AAAS describes public engagement with science as intentional, meaningful interactions that provide opportunities for mutual learning between scientists and members of the public.

Through the Alan I. Leshner Leadership Institute for Public Engagement with Science, AAAS empowers scientists and engineers to practice high-impact public engagement by fostering leaders who advocate for critical dialogue between scientists and the public and lead change to enable their communities, institutions, and others to support public engagement.

The typology below, with additional work on understanding mechanisms for institutional change, as well as practical experience in public engagement with science, will guide the work of the Leshner Leadership Institute, as well as other programs of the AAAS Center for Public Engagement with Science (Center).

The Center, which manages the Leshner Leadership Institute, offers this typology as a resource for the broader community of public engagement practitioners, researchers, and scientists doing public engagement.

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Introduction

Scientific researchers are now regularly venturing beyond the ivory tower of academia to share their findings with various publics. Traditionally, this science communication and educational outreach have been constructed as a one-way stream during which scientists provide publics with information that was to fill a knowledge gap (deficit model). Within this paradigm, effective communication or outreach was based on sophisticated and sometimes evidence-based methods to reduce the complexity of scientific findings and provide publics with scientific information that was simultaneously understandable and accessible to non-experts in a specific scientific domain and scientifically correct (as judged by experts in that domain). Over the course of the last 40 years, this deficit/expert model of science communication and outreach, while still dominant and widespread, is increasingly being supplemented, and sometimes even replaced, by a different paradigm for science communication and outreach: science engagement.

AAAS and Public Engagement with Science

The American Association for the Advancement of Science (AAAS) provides the following working definition: *Public engagement with science describes intentional, meaningful interactions that provide opportunities for mutual learning between scientists and members of the public* (Braha, 2015: 18). Following this definition, core attributes of public engagement with science include the following (1) scientists consider the needs, desires, affordances and abilities of their audiences; (2) engagement is structured as bi-directional dialogue between scientists and audiences; and (3) scientists and their audiences feel empowered to be part of a mutual learning experience that influences. But why define public engagement as distinct from science communication, particularly if there are invariable grey areas between the two concepts? We see the primary value of a clear definition and delineation in protecting the concept from linguistic and conceptual murkiness, something that would weaken its application and our ability to train, track, and evaluate its effectiveness.

Typology for Public Engagement with Science

This document represents one aspect of this effort. Here we are developing one of many possible conceptual framework for public engagement with science, which we will refer to as a "typology." This typology is designed to help scientists develop a basic sense of the various options to effectively engage public audiences and thus understand the landscape of public engagement with science. For the purpose of this particular framework, we assume that "scientists" are professionals with advanced and often terminal degrees and who are actively engaged in research and the production of new knowledge (e.g., applied researchers, engineers, and graduate students).

Secondarily, this document can also inform practitioners who work in various engagement or outreach-oriented institutions and organizations and who provide the platform or

organizational infrastructure, training, and events that allow scientists to engage directly with publics (e.g., science museum, science festivals, science pubs). And thirdly, the document's detailed categories and rubrics provide a resource for evaluators and researchers who are interested in common or shared ways to describe and characterize science engagement activities by scientists. While not directly applicable to survey instruments or observation protocols, the categories and detailed rubrics nonetheless suggests a wide range of potential determinants that define quality of science engagement, including outcomes for participants and scientists. As such, this typology will help identify and use appropriate measures for documenting and understanding the quality of public engagement activities by scientists. It follows similar frameworks that have been developed to create an observation instrument of educational quality of scientist-led environmental field days (Carlson, Heimlich, Storksdieck, & Mayer, 2009) or of educational quality of STEM engagement in afterschool settings (Dimensions of Success observation tool by the Program in Education, Afterschool & Resiliency at Harvard University).

How is the typology organized?

The typology description consists of three sections:

- Background information on general ways to think about public engagement with science
- The typology of public engagement with science organized into specific categories and within-categories rubrics for describing engagement activity types
- Short summaries of select public engagement with science activity types

In the introduction and the background section, we provide a broad overview on public engagement with science along with background information on how to use the typology. In the section *Categories and Rubrics for Public Engagement with Science,* we list a series of categories, such as event type, depths of engagement, or target audience, that form descriptive dimensions of public engagement and that are associated with quality of such activities. They are the broad-based variables or constructs that, collectively, will describe the nature of a public engagement activity. For each of the categories, we suggest a rubric, or expressions of the qualities within the categories that could form the basis for assessment or evaluation instruments, whether those are based on observation or participant responses. We suggest that our categories and rubrics allow for a reasonable and objective description of engagement activities. Nonetheless, we acknowledge that there are many different ways in which to describe engagement events and that our categories and rubrics are not fixed. Finally, in the section *Examples of Public Engagement Activities,* we provide short example narratives for different activities that can support public engagement. The line between one-way communication and two-way engagement can be blurry, and some activity types might fall on one side or the other depending on how they are conducted. For example, science cafés can be (and often are) lectures with Q&A in public settings; however, they can also be opportunities for dialogue and mutual learning, where scientists seek insights from conversations with the audience. Thus in this section,

we offer specific examples of the presence and absence of two-way exchanges between science and non-scientists.

Limitations and exclusions

For the purpose of this document, we assume that an underlying infrastructure for public engagement with science is present, whether that is in the form of a science festival, science café program, or science slam event, exchange on social media, meeting with policy maker or stakeholder, etc. Developing, managing and sustaining this "infrastructure" goes beyond the scope of this working paper. Note also that we do not address casual one-on-one encounters between scientists and publics. These can be important and enriching conversations that deeply impact both parties, which can occur during everyday encounters that achieve the same objectives as more structured or planned activities.

Section 1: Background

Direct interactions with audiences allow for immediate feedback

When direct encounters are intimate, they allow for personally directed dialogue between the scientists and the "public." Such encounters with individuals or small groups include discussions with family members, neighbors, or friends that are either planned or incidental; they could also be encounters at an activity table during a science festival or field day, or during some interpretation as a docent at a science museum. They could also include interactions with policy makers, industry representatives, media, or marketing experts. These encounters are excellent opportunities for true dialogue in which scientists listen to the concerns, perspectives, positions and questions of the other participant(s). Even when scientists are asked to explain their current scientific research, or to provide context or explain some scientific phenomena, intimate encounters are characterized by the opportunity to be bi-directional dialogue rather than "lecture" in which the scientist "unloads" his/her knowledge on the person.

Large-group encounters (public lectures, science cafes, story colliders, etc.) are characterized by the same limitation for engagement as lecture halls or classrooms. When "on stage," scientists have fewer opportunities to respond to direct feedback, or visual and audio cues than when they are in direct contact with audience members. Typically, the scientists cannot orient towards each and every participant, and the opportunity for direct engagement is limited, making it almost impossible for the scientists to gauge with ease whether the audience/participants' needs are being met. This can dramatically change the feel of the interaction between scientist and audience. Nonetheless, there are strategies that scientists can use to better "engage" the audience, ranging from frequent and generative questions to polling and other techniques that ask audiences for collective feedback.

Public engagement with science can occur in-person or online

The online environment now provides almost the same vast array of opportunities for scientists to engage as the in-person environment, with the added benefit of potentially far lower transaction costs for both, scientists and the public (i.e., going places). Scientists now operate their own blogs, use Twitter, Facebook, and LinkedIn as means to exchange ideas with the public or with more select groups of "friends" and "colleagues"; they participate in webinars, MOOCS, discussion forums and comment on posts by others, including newspaper and magazine articles; they volunteer as facilitators on Reddit and editors on Wikipedia. The possibilities seem endless; yet whether, how (much), and how well a scientist engages online is still a question for more research (Yeo, 2015). Some are making conscious choices and carefully curate an online persona (including professional who communicates with a broader audience). Others may act more opportunistically and with less purpose; current survey research with scientists (Besley, Dudo and Storksdieck, 2015) is beginning to provide a clearer picture of why and in what ways scientists are engaging online, but little is known about the collective impact of this online science engagement. Furthermore, we know little about the line between traditional science communication (where scientists us various online platforms to broadcast their ideas) and true science engagement (where scientists use the direct connection with non-scientists as a means for mutual exchange and learning).

Basic principles for successful engagement

What emerges across many different types of public engagement with science are some basic principles that seem to characterize successful engagement, many of which could also be considered basic principles of good interpersonal communication. They include a genuine curiosity for the other (in our case members of the audience or public); willingness for deep listening; an openness to hear other perspectives and positions and learn from audience members; a willingness to limit the amount of information conveyed to just what is needed in the situation (i.e., an ability to perceive, and a positive disposition towards responding to the need of the audience); an ability to be accurate while being tolerant towards some level of scientific inaccuracy; willingness to make personal connections with audience members (allowing audiences to form a connection to a scientist); and most importantly, avoiding confrontational interactions with audiences over questions related to norms, values, or beliefs.

Section 2: Categories and Rubrics for Public Engagement with Science

Below is table with key elements for developing rubrics of science engagement. It lists categories of science engagement with detailed descriptions of each category.

ENGAGEMENT CATEGORY	DESCRIPTION
Size of the engagement	❖ One-on-one or small group ➢ *For example, interpretation in designed settings (e.g., activity carts in science museums), briefings with decision-makers* ❖ Large group ➢ *For example, seminars, science cafes, science slam, science festival, webinar, twitter, blog*
Form of engagement	❖ In-person ❖ Remote or online ➢ *Synchronous such as webinar or forum* ➢ *Asynchronous such as blog or twitter*
Physical dimensions and context of engagement	❖ Overt science focus (e.g., *science talk)* ❖ *Covert* science focus (e.g., *science embedded in art talk)* ❖ Overt science setting (e.g., science center, research lab) ❖ Covert science setting (e.g., art festival, café, pub)
Structural aspects of engagement (non-observable)	❖ Event linkages ➢ *Isolated event* ➢ *Part of series or larger project* ❖ Support from public engagement practitioner ➢ *Yes* ➢ *No* ❖ Extent of preparation ❖ Extent of intent to engage public in science process/dialogue
Depth of engagement (dosage)	❖ Time ➢ *<5 minutes* ➢ *5-15 minutes* ➢ *16-60 minutes* ➢ *1-4 hours* ➢ *1 day* ➢ *More than 1 day* ❖ Dominant voice ➢ *Mostly scientist* ➢ *Equally scientist/participant* ➢ *Mostly participant* ❖ Power/control ➢ *Mostly scientist* ➢ *Equally scientist/participant* ➢ *Mostly participant* ❖ Repeatability ➢ *One time only* ➢ *Part of a series* ➢ *Potential to repeat* ❖ Scalability ➢ *Unique* ➢ *Limited scalability (local or temporal restrictions)* ➢ *Highly scalable* ❖ Pre/post engagement intended *(Yes/No)* ➢ *For example, readings, data collection, follow-up already planned, etc.* ❖ Level of involvement of scientist *(minimal to extensive)* ❖ Level of involvement of participant *(minimal to extensive)*

ENGAGEMENT CATEGORY	DESCRIPTION
Content	❖ Type ➢ *Physical/chemical sciences* ➢ *Earth (system) sciences* ➢ *Life sciences* ➢ *Engineering/technology* ➢ *Social sciences* ❖ Temporal research aspect ➢ *Past research* ➢ *Current research* ➢ *Future research* ❖ Type of research ➢ *Basic science* ➢ *Applied research* ➢ *Product development* ❖ Level of potential controversy around the topic ➢ *Low* ➢ *Medium* ➢ *High* ❖ Societal dimension ➢ *Low* ➢ *Medium* ➢ *High* ❖ Framing for research ➢ *Current research is focus; basic understanding of scientific concepts used to understand current research* ➢ *Current research is "hook" for introducing basic scientific concepts*
Scientist/Engineer type	❖ Length in profession ➢ *Graduate student* ➢ *Early career* ➢ *Mid career* ➢ *Late career/retired* ❖ Field ➢ *Physical/chemical sciences* ➢ *Life sciences* ➢ *Earth (system) science* ➢ *Engineering/technology* ➢ *Social sciences* ❖ Position ➢ *Instructor* ➢ *Researcher* ➢ *Resource manager* ➢ *Administrator*
Participant type	❖ Age ➢ *Child (<10 years old)* ➢ *Youth (10-18 years old)* ➢ *Adult (19-65 years old)* ➢ *Senior (>65 years old)* ❖ Gender ❖ Audience composition ➢ *Homogeneous (e.g., only adults)* ➢ *Heterogeneous (e.g., mixed family groups)*

ENGAGEMENT CATEGORY	DESCRIPTION
Motivation for engagement (participants)	❖ Personal reasons (self) ➢ *General interests/curiosity/enjoyment* ➢ *Specific interests (e.g., hobbyism)* ➢ *General concerns (e.g., environment, science funding)* ➢ *Personal concerns (e.g., medical conditions, faith)* ❖ Social reasons (concern for others) ➢ For example, accompanied family/friend; group; wants to provide ❖ Professional reasons (links to a person's work) ❖ Affinity to science ➢ Closeness/distance to the nature, process or concepts of science through education, work, family/friends, etc.
Motivation for engagement (scientist)	❖ Personal reasons (self) ➢ *Desire to improve science literacy* ➢ *"Lobby" for science in general* ➢ *"Lobby" for increased/sustained societal support for science* ➢ *Satisfaction/enjoyment to engage with public* ➢ *Supplementary activity for increased fulfillment/job satisfaction* ❖ Professional reason ➢ Part of job requirement ➢ Fulfillment of Broader Impacts requirements ➢ Believe in professional obligation to engage ➢ Positive contribution to professional advancement ➢ Desire for visibility of own research
Nature of engagement	❖ Entertainment (activity mostly serves to provide entertainment and enjoyment – science provides context) ❖ Exploration (explore with audience various scientific ideas/principles) ❖ Conflict transformation (addressing controversial topics and focusing them on the scientific foundation) ❖ Individual decision-making (help audience in making informed choices based on science) ❖ Collaborative action (use scientific expertise as input to a democratic or group process that charters a path for addressing a societal issue)
Engagement actions (participant and scientist)	❖ Speaks/presents/demonstrates ❖ Asks questions ❖ Answers questions ❖ Engages in dialogue/debate ❖ Co-creates, makes, builds ❖ Explores, detects, searches ❖ Advises/mentors ❖ Engages in informal dialogue in conversational style

ENGAGEMENT CATEGORY	DESCRIPTION
Interaction during engagement (participant and scientist)	❖ Allowing time for others to speak ➢ Minimal ➢ Moderate ➢ A lot ❖ Asking questions ➢ None ➢ Few ➢ Some ➢ Many ❖ Providing answers ➢ Scientists only/mostly ➢ Scientist and audience ➢ Audience only/mostly
Declared outcomes for scientists	❖ Becoming reflective about their engagement practice ❖ Gaining positive attitude about public engagement in science ❖ Gaining enhanced understanding of the value of their own science for public audiences (ability to clarify public value) ❖ Gaining enhanced motivation for conducting research and/or appreciation for/valuing of own research ❖ Gaining enhanced understanding of the current public dialogue or controversy ❖ Gaining enhanced skill in and self-efficacy for engagement (including norms for engagement and balancing tensions of science "truth" and public perception of science impact) ❖ Gaining enhanced engagement/broader-impact identity ❖ Orienting research agenda towards societal concerns through reflection of social implication of one's research (responsive or engaged research)
Declared outcomes for participant	❖ Gaining enhanced interest in science ❖ Gaining positive affect for science ❖ Gaining connectedness/lower psychological distance to science topics ❖ Being satisfied (immediate) with science engagement experiences ❖ Gaining enhanced awareness of research and researchers within a community ❖ Gaining enhanced understanding of science, nature of science and/or process of science ❖ Gaining enhanced understanding of the current public dialogue or controversy ❖ Gaining enhanced skills in critical thinking, science process and/or civic engagement ❖ Gaining enhanced self-efficacy to participate in science engagement and/or science process ❖ Developing new/enhanced science identity ❖ Developing positive disposition towards follow-up and subsequent reinforcing experiences (intention to act)

Section 3: Examples of Public Engagement Activities

Many different activities types provide opportunities for scientist to have meaningful dialogue with public audiences. This include events that are familiar to scientists such as focused talks presented by scientists to community organizations; public seminars led by scientists and often hosted at science institution; and guided tours led by scientists at their home institution, education institutions (e.g., museums, zoos, aquariums), parks or other settings. However, less well-known activities also support science engagement including citizen science, star parties, science slams, science pubs, science blogs, various festivals (e.g., science, art, culture) and competitive events (e.g., hack-a-thons), and maker faires. None guarantee science engagement, but each harbor the potential if certain provisions for bi-directional interaction are made. The table below lists various types of public engagement activities and, for each, provides examples of engagement and lack of engagement (as defined in this typology).

Major approaches to public engagement with science include knowledge co-production, pubic dialogue, policy deliberation (Nisbet and Markowitz, 2015). The examples in the typology, assuming the presence of engagement quality, are categorized by the approach they represent.

Policy deliberation approaches provide opportunities for a variety of stakeholders to participate in a dialogue and exchange of views about science policy.

In public dialogue approaches the goal is to promote dialogue as an end in itself, recognizing that informal discussions with the public result in learning on behalf of both the public and experts.

Knowledge co-production approaches sponsor "intentional collaborations in which members of the public engage in the process of research to generate new science-based knowledge" (Shirk et al. 2012).

University-led cooperative engagement approaches emphasize trust building and social learning in collaboration with key stakeholder groups.

The activity types covered in the table are:

- Citizen science
- Star parties
- Science slam, science story collider, science poetry slams
- Science café or pub
- Online science blogging
- Science festival
- Maker Faires
- Make-a-thons, Hack-a-tons, Create-a-thon

- Public Advocacy Days
- Deliberate democracy forum

Activity type (public engagement approach)	Brief description	Example with engagement presence	Example with engagement absent
Public participation in research (knowledge co-production)	Projects that directly involve public in science research and monitoring, often to collect data over large temporal and/or spatial scales, analyze large datasets, or propose a multitude of possible solutions; this can include citizen science and participation action research and may be driven by science or public needs/interest.	The scientist has direct and regular communication with volunteers (in-person or online) as they work on one or more aspects of a research study (e.g., define research question, analyze data).	The scientist post the research question and protocol on a website. Volunteers follow the protocol to collect and submit quantitative data. The scientist downloads these data for the study and posts a thank-you with brief summary of the research findings.
Star parties or other interpretation	Evening public events when hobbyist or professional astronomers provide night sky tours (telescope viewing of objects in the night sky).	As the participant looks through a telescope, the astronomer asks him/her to describe what they see. The two then discuss differences in what they observe and why they each notice different things.	As a participant looks through a telescope, the scientist describes heavenly bodies in the field-of-view. The participant thanks the scientists and moves onto the next telescope.
Science slam, science story telling, science poetry slams (public dialogue)	Short (≤10 minutes) creative interpretations of science given by scientists and non-scientists in a casual venue and judged by audience members based on their entertainment value.	Scientist prepares and delivers a concise, clear, dynamic and compelling literary piece related to science, based on perceived audience reactions. The audience provides honest responses and feedback to both the content and delivery. Scientist takes feedback into account for next iteration.	The scientist does not consider audience and/or does not approach science presentation with a creative literacy lens. Or they simply don't sign up!
Science café or pub	Relaxed presentations, discussions and/or debates in a casual setting	Scientist prepares and delivers a brief overview of a topic linked to	Scientists uses an existing talk and makes it "easier to understand" by

(public dialogue)	(often including food and spirits) that are facilitated by scientists and focused on a particular timely or relevant science topic. May or may not be announced as such to the audience.	science and relevant to the audience. He/she also has a list of questions to promote discussion with and among audience members. Much of the rest of the casual evening is spent in conversation about the topic, including discussions on the type of research that would be interest and perspective of the audience.	making some changes to Powerpoint. He/she delivers the talk and engages in Q&A mostly associated with conceptual understanding of the audience. He/she tends to privileges the questions and contributions of the most knowledgeable audience members.
Science blogging (public dialogue)	Regularly updated online journal or commentary that have one or more authors, address one or more science topic, allow dialogue through follow-up asynchronous comments, and can use existing hosting services such as Twitter, Facebook, Snapchat, and Instagram.	The scientist considers a topic relevant to a specific audience and starts and regularly updates a blog on this topic. Audience members submit comments to these posts, which the scientist and other participants respond to, creating an extended dialogue.	The scientist selects a topic of interest to him/her, starts a blog and regularly updates it. Audience members do not have opportunity to comment, or post comments, but the scientist does not respond to the comments, or provides responses that discourage ongoing exchanges.
Festival (public dialogue, stakeholder engagement)	Large single- or multiple-day gatherings in indoor and/or outdoor venues that can include workshops, lectures, tours, exhibitions, demonstrations, and participatory activities; these can be focused on science (e.g., cutting-edge research, controversial issues) or can be focused on other topics (e.g., art, music, history) and have a science component that is	The scientist prepares an interactive demonstration with simple props. After a brief demo, he/she uses the props to ask open-ended questions. Many festival attendees spent time at the demo to watch, respond to questions and ask their own questions.	The scientist prepares a visually-compelling demonstration. He/she thoroughly explains the demo. Many festival attendees stop to watch and listen to the demo, and then move on without talking to the scientist.

	either explicit or covert (as in Guerilla Science).		
Maker Faires (public dialogue)	Small to large single- or multiple-day gatherings in indoor and/or outdoor venues that center on using creativity and invention to explore new products and technologies and that provide hands-on and skill-building activities.	Judge – asks questions, pays close attention, engages makers in conversation around their motivation, ideas and relates this to their his/her own research, discussing with "makers" how their research might change as a result of the discussion. The scientist brings materials that could be used to construct a field-based data-collection instrument. He/she and faire attendees work together to explore different strategies to make this instrument, discussing pros and cons of their different prototypes.	The scientist brings a "homemade" field-based data-collection instrument. He/she demonstrates how it was constructed. Many festival attendees stop to watch the demo, and then move on without talking to the scientist. Few try to replicate the design.
Make-a-thons, Hack-a-tons, Create-a-thon (public dialogue)	Small to large single- or multiple-day gatherings in indoor and/or outdoor venues that center on a challenge with a limited time frame and judged by attendees and/or juries.	The scientist joins a team of tinker-attendees to create a product. They work as equals to plan, design, and build their product. Other attendees evaluate the product, providing valuable feedback	The scientist leads a team of tinker-attendees to create a product. He/she has already determined all necessary elements and provides step-by-step instructions to other team members to build the product. Other attendees judge the product without providing any feedback.
Policy Briefings (public	Meetings to promote awareness and understanding of science	A scientist prepares and distributes a concise summary of	A scientist prepares and delivers a comprehensive review of elements

dialogue, knowledge co-production, stakeholder engagement, policy deliberation)	related (policy) issues with key legislatures or government officials (or their staff) [Note: can be similar to one-on-one or small-group conversations in everyday settings or with other stakeholders].	elements of the issue. He/she begins by inquiring about needs and perspective of the legislator or official. Afterwards he/she connects his/her expertise directly to these needs and perspectives. At the conclusion, scientist and legislator/official agree to continue the discussion if more question arise.	of the issues, which takes much of the allotted time. He/she asks the legislator/official if there are any further questions. The legislature/official asks a quick polite question, and then the meeting concludes.
Deliberative democracy forum (policy deliberation, stakeholder engagement)	Small to large event that focus on dialogue around a contentious science-related issue and provides equal time for scientist and stakeholders to share their knowledge, needs, concerns and questions.	A scientist organizes key points about the issue. He/she begins by inquiring about needs and perspective of the stakeholders. Afterwards he/she connects his/her expertise directly to these needs and perspectives. The stakeholders state their understanding and concern. Both groups discuss common ground and areas of disagreement based on joint meaning-making of the underlying science and other aspects that influence decision-making (norms, values, conflicting interests, etc.). Both sides develop different strategies to address the issue.	A scientist prepares and delivers a detailed description of the issue including responses to anticipated questions of a (perceived to be) ill-informed public. The stakeholders state their understanding and concerns, using provided science lecture to strengthen their conviction of their position. Both sides use the event as a means for persuasion, with the expectation that "the other side" will change perspective.

Resources

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