Understanding the informal science education landscape:
An exploratory study

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Abstract

This study investigated the informal science education (ISE) field to determine whether it currently functions as an effective community of practice. Research questions included: How do professionals describe and self-identify their practice, including what missions, goals and motivating factors influence their professional work? What challenges do they face and how are these resolved? Is participation in ISE activities perceived as central or ancillary to their work? Open-ended interviews were conducted with high-level representatives of 17 different ISE sub-communities; results were analyzed qualitatively. Findings showed this broad assortment of ISE sub-communities as not currently functioning as a cohesive community of practice. Although examples of shared practice and ways of talking were found, evidence of widespread, active relationship-building over time and coalescence around issues of common concern were absent. The article explores possible reasons for the current state of the ISE field and speculates how future events might influence these realities.

Key Words: informal science education, community of practice

Acknowledgements

1.   Introduction

Most societies claim, at least rhetorically, that a fundamental goal is building a learning society in which every citizen has the desire, abilities and tools to fulfill his or her quest for knowledge and engagement, including knowledge and engagement in the critically important fields of science, technology, engineering and mathematics (STEM). Although traditional formal educational organizations play an critical role in supporting STEM learning, there is growing awareness of the contextual nature of learning which assumes that attitudes toward, and knowledge and understandings of STEM are equally if not more likely to be shaped by an individual's direct and personal experiences, needs, expectations, and culture (cf., Bell, Lewenstein, Shouse and Feder, 2009; Falk, Storksdieck and Dierking, 2007; Sturgis and Allum, 2004; Turner, 2008; Wagner, 2007). This perspective places a greater emphasis on the contributions played by the vast network of informal science education entities – including, but not limited to science museums of all kinds, community-based organizations with mandates for informal STEM learning, STEM-oriented television, film, books, afterschool STEM education and the Internet – which are ideally suited to support the public's ever-expanding desire, and at times need, for free-choice STEM learning, across their lifetimes and throughout the day.

In part to help fulfill this potential, the U.S. National Science Foundation (NSF) funded the Center for the Advancement of Informal Science Education (CAISE), designed to create mechanisms to facilitate participation in, and leadership within, the free-choice STEM learning community; this exploratory research study was an initial effort to explore and document the current "landscape" of the informal science education community. The study was based on the premise that in order to create a dynamic, grassroots community, one first needs to understand who identifies with and currently participates in that community, as well as who currently does not. Also important to understand are the broad questions and issues various members of this community believe they face and the tools they perceive they require to improve their practice and support their work. However, beyond the needs of CAISE, this research provides the greater Informal Science Education (ISE) community insights into whether a wide range of educational professionals do, or do not identify themselves as participants in the ISE community which has implications for how they organize themselves and collaborate in support of the public's informal STEM education.

2.   Research goals and design

The overarching goals of this study were to determine the current state of the ISE field (primarily in the U.S.), and the degree to which it functions as an effective community. To accomplish this goal the study explored the "landscape" of the informal science education community to determine what currently seems to constitute this community and what potential community-building might be useful. Our research questions included:

- How do (presumed) ISE professionals describe and self identify with their professional community, including what missions, goals and motivating factors influence their professional community's work? Specifically, are the goals and practices they identify with shared by others within the ISE community?
- What challenges do various professional communities within ISE face and how and to whom do they make the case that what they do is important?
- From whom do they seek funding and how do they perceive and position their professional community with respect to ISE?
- For those whose professional community does identify with, and participate in the ISE community of practice to any degree at present, in what ways do they identify and/or participate? Is participation central to their work or ancillary?

3.   Theoretical framework

The theoretical framework for the research was *Community of Practice* (CoP). A CoP is "a unique combination of three fundamental elements: a *domain of knowledge***,** which defines a set of issues, a *community of people* who care about this domain**;** and**,** the *shared practice* that they are developing to be effective in their domain" (Wenger, McDermott, and Snyder, 2002, p. 27). Shared practice suggests similar ways of talking about the work at hand, solving problems, getting things accomplished or finding and processing information. In the case of this research, the domain of knowledge is ISE, the community is ISE professionals and the shared practice includes exhibition, program and new media development, journalism and film-making and so on, all focused on STEM.

The CoP construct posits that participation within a community influences the identity of the participants and that individuals evolve as a result of their participation in the community. In addition, the community evolves as a result of their participation and influence. This framework shows promise as a useful paradigm when trying to document the broad, strategic impact of a specific field of practice, which seemed a particularly useful theoretical framework with which to explore and document the current "landscape" of the informal science education community. A critical first step in fostering a dynamic grassroots community is to understand who currently identifies with and participates in the community, as well as who does not identify with the community nor participates.

Our working hypothesis was that if the multiple individuals and organizations that make up the ISE community are truly a CoP, we would be able to describe them as a group of people who share common goals, for example a concern or passion for STEM, and engage in shared practice through regular social interaction with each other as they strive towards meeting those goals; in particular through the vehicle of informal education. An effective CoP shares much more than a common set of products, information or skills though. To create, nurture and sustain a dynamic community, members must participate in active relationships over time (Lave and Wenger 1991; Wenger, 1998) and organize around issues that matter to members of the community (Wenger, 1998). This active and dynamic community would be able to be observed and documented.

Although the CoP construct was originally conceptualized as a way to describe and understand relatively small, narrowly delimited domains, such as apprenticeships between midwives in the Yucatan area of Mexico, it has increasingly been used as a way to frame larger, more complex multidisciplinary communities in which individuals from several different professional communities or disciplines overlap and share information, tools and resources to advance a common goal. Although arguably large, multidisciplinary communities are much less common than single disciplinary communities of practice, it is clear that they are growing in importance as the world is becoming ever more interconnected and there is a growing appreciation for the multidimensionality of most issues of importance. The ISE community should theoretically represent a classic example of a complex, multidisciplinary community of practice. Members of the ISE community specialize in communicating STEM to the public through a wide array of media, including exhibitions, print, film, broadcast and on-line media, lectures and individual-to-individual. Each mode of communication involves a unique expertise and comprises its own discipline. However, though disparate communities in and of themselves, these disciplines, have the potential to come together in order to serve the common goal of helping inform the public about STEM via out-of-school mechanisms.

Appreciating the diversity of a multidisciplinary CoP is important because there are differences in how, and to what extent, the various sub-communities within ISE may choose to identify and participate. For example, there are some sub-communities such as science centers, for which ISE is probably considered at the very core of their work; it may even be the primary reason for their existence, and thus already is an integral part of their day-to-day thinking and operation. In other sub-communities, ISE may not be the central focus of participants' work nor the professional community / communities with which they identify. Informing the public about science through informal education may be an important goal, however, not their only, or even primary, goal. In these communities, some or much of their time may be dedicated to activities such as research, conservation or formal education that would not be considered ISE-focused.

To deal directly with this critical distinction we used slightly different terms and meanings than those commonly used in the CoP literature to describe participation in the ISE community. In CoP research, levels of participation are differentiated along a trajectory ranging from peripheral engagement to active engagement to core participation. Peripheral engagement refers to a novice member who is participating for the first time or does so infrequently, active engagement refers to members who participate and/or contribute frequently in a long-term capacity, but not in leadership roles, and core membership refers to a member who is a sustained participant who assumes leadership roles, defines her/his professional identity related to this participation, and whose participation contributes both to her/his own evolution and that of the CoP (Lave and Wenger, 1991).

In contrast we used the terms "ancillary" and "central" to describe participation in the ISE community. Unlike the traditional terms, ancillary and central are not associated with the experience nor expertise of the individuals or communities involved, but rather

the degree to which ISE is fundamental to the work they do; we do this to minimize any sense of judgment associated with a sub-community's level of participation in the broader ISE community. Participating as an ancillary member does not mean that the significance, quality, dedication or impact of the participation is less valued than those communities that identify with ISE more centrally. Of course implicit within the CoP framework, is the assumption that as the understanding of the value of ISE increases nationally and internationally, groups that currently perceive ISE as ancillary to their goals might choose to make ISE more central. In addition, as CAISE and other entities working to support ISE continue to emerge as *useful* entities that support this multidisciplinary CoP, one could also track changes in the landscape of participants and their identification, participation, and leadership within the free-choice STEM learning community. Thus this study also serves as a baseline for longitudinal   research which could track the impact and influence of CAISE, and other community-building efforts over time.

An important note is that even though we have discussed CoP from the perspective of the individual, the unit of analysis for this study is actually the professional sub-community to which the individual relates. Some individuals in an ancillary community may spend all of their time doing ISE work; likewise, there are individuals in communities in which ISE is central, but s/he is not personally involved in ISE activities. Categorization of professional communities was not meant to describe every individual in that sub-community, but rather the general role of ISE in the practice of the sub-community as a whole.

It is also important to note that community of practice is not the only theoretical framework through which the ISE community could be studied and analyzed. For example, a neo-institutional theorist might categorize the community as an organizational field. As defined by DiMaggio and Powell (1983, p. 143), an organizational field consists of "those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, resource and product consumers, regulatory agencies, and other organizations that produce similar services or products." The assumptions and approaches that underlie institutional theory are quite different from CoP and it is possible that an institutional theory lens could also provide insights into the ISE community. However, because we were more interested in the community identity aspects of ISE, we designed the interview protocol and questions utilizing the CoP framework, and chose to analyze and interpret the data through that theoretical lens.

4.   Methods

Study design

This study was designed as a focused, exploratory research effort, employing a community of practice approach to understand the ISE community within a larger sociocultural context. By design, the sample size was small and focused. Rather than being definitive, these data were intended to provide a glimpse into the ISE professional community from a diversity of its participants, some whose work is central to ISE and some whose is more ancillary. Data were collected through in-depth telephone and face-

to-face interviews with education leaders and professionals from diverse professional communities engaged in communicating science to the public. Because of its exploratory nature, interview questions were open-ended in nature. For example, interviewees were asked: "How does your community contribute to communicating science to the public? If not science, what, if anything, are you trying to communicate to the public?" A relatively small, convenience sample of potential ISE professionals to interview were assembled by the research team using CAISE's (and our) extensive network of contacts within the ISE field to enable a detailed examination of each person interviewed and their perceived community of practice. The sample included individuals from a wide variety of groups involved in the development, production, dissemination, funding, and support of informal science education activities. The final interview list included representatives from: Youth-Serving Community Organizations, Adult Community Organizations, Science Centers, Botanical Gardens, Natural History Museums, Zoos and Aquariums, Children's Museums, Environmental Organizations, University Extension, Public Television and Radio, Journalists, Health Organizations, After-School Science, New Media Researchers, Libraries, Science Societies and Film Makers (for a complete list refer to Appendix A).

In order to gain an unbiased view of the field, we developed selection criteria that insured diversity in terms of: focus of work; expertise; size of the organization(s) represented; and geographic location. Although the majority of the sample interviewed, were from the U.S., individuals from Europe, Canada and Australia were also included. Most importantly, we attempted to select individuals who were prominent within each of the target sub-communities. Suitable research participants included association executive directors, organizational directors and deputy directors, national funders and internationally recognized ISE professionals, all of whom we felt could credibly represent the professional *community or communities* in which they participate since the unit of analysis was not the individual.

Also because the National Science Foundation's Informal Science Education program is the dominant funder of out-of-school STEM efforts in the U.S., we assumed that their rhetoric and philosophy likely impact the field. We were particularly sensitive to this given that our own efforts were being supported by the NSF ISE program. Thus we hypothesized that individuals currently funded or impacted by NSF ISE would more strongly: (1) connect to the domain of knowledge embraced by ISE; (2) identify with the community of people who consider themselves a part of the ISE CoP; and (3) consider ISE more central to their shared practice. In an effort to be able to consider the influence of NSF ISE as an independent variable we made a conscious decision to capture the opinions of both a group of individuals exposed to the programmatic rhetoric and philosophy of the NSF, e.g., the core group of individuals who regularly apply for and receive funding from the NSF ISE Program, as well as a sampling of individuals outside of this sphere of influence, e.g., individuals not recently receiving NSF ISE monies or those who have not received funding at all. Though not recipients of NSF ISE monies, by virtue of their positions and activities this group of individuals were still considered leaders or emerging leaders in the ISE field but they were not necessarily as influenced by NSF ISE's rhetoric and philosophy.

Face-to-face interviews were conducted with a subset of the NSF ISE funded core group during an ISE PI Summit hosted by CAISE in July 2008 in Washington, D.C. Individuals were approached during the conference and asked to participate in the study. Thirty-five individuals deemed to be outside the core group were contacted via email and invited to participate in the study. In compliance with IRB procedures, participants were provided with general information about the purpose of the study, both as part of the invitation to participate, and in the introduction to the interview.

Interview protocol

Interviews were open-ended and conversational in nature. Such an approach builds rapport and trust with the person being interviewed, which enhances the validity of findings, allowing a researcher to better understand what people actually say and do in places with other people (Goodwin and Horowitz, 2002). The goal of each interview was to better understand how individuals from a variety of representative communities within ISE, described and positioned themselves, the particular professional community within ISE with which they identified, and what the major challenges in their community were. Questions generally probed research participants about their community identity, the domain of knowledge involved and their shared practice in terms of: 1) the missions, goals and motivating factors of their community; 2) obstacles to meeting their community goals; 3) how the community makes the case that what they do is important and to whom they make that case; 4) where the community goes to get funding; and 5) how the community perceives itself in relationship to ISE. In order to eliminate bias, information about CAISE and its funder were not made explicit until the end of the interview unless this information was specifically requested. A copy of the interview protocol is included in Appendix B. Face-to-face interviews and those conducted by phone utilized the same protocol.

Analysis

All interview data were reduced, categorized and coded by researchers. Data were analyzed using text analysis, a qualitative, detailed method for identifying concepts and categories that emerge from interviews (Bernard and Ryan, 1998). This approach allows researchers to systematically identify, code, and categorize primary patterns or themes within participants' responses, enabling researchers to recognize rich and complex patterns across cases, and to capture the often complex and unpredictable ways in which these patterns are related to one another. Cross-validation of these codes and a member check with representative ISE professionals not in the sample were also conducted.

5.   Results

All ten of the individuals approached for face-to-face interviews agreed to participate. Of the thirty-five individuals contacted via email three declined to participate in the study due to time constraints, three agreed to be interviewed but a time was never able to be scheduled, and four never responded to the request. Thus ten face-to-face interviews were conducted, along with twenty-five phone interviews resulting in a total "n" of thirty-five. There seemed to be no selection bias in terms of who agreed to be interviewed; most who declined indicated that time constraints prevented them from participating in the study. Both the phone and face-to-face interviews lasted on average 45 minutes.

As mentioned earlier, it was hypothesized that compared to those not currently funded or impacted by NSF ISE directly, ISE-funded individuals would more strongly: (1) connect to the domain of knowledge embraced by ISE; (2) identify with the community of people engaged in ISE; and, (3) consider ISE more central to their shared practice. Interestingly though, qualitative analysis of the data demonstrated that responses from both groups were essentially identical; comparisons of responses as a function of this variable yielded no additional insights. Thus it was determined that the need to keep these two groups separate was unnecessary and all further analysis was conducted using responses from all research participants combined.

The results of data analysis and interpretation did not fall cleanly within the three fundamental elements of CoP: the domain of knowledge; the community of people engaged in the domain; and, their shared practices. Instead, considerable overlap among and between the three elements was observed. In particular, distinguishing between the community of people engaged in the domain and their shared practice was difficult; consequently we discuss those CoP elements together. It is also highly likely that the difficulty distinguishing these elements is an artifact of this being a complex, multidisciplinary community of practice.

Domain of knowledge

When asked to identify the professional community or communities with which they engage, only about 15% (5 of 35) specifically mentioned Informal Science Education without prompting. The most common type of response was given by about half of those interviewed and related to the person's institutional or domain identity (science centers, museums, environmental education, etc). Some typical responses were:

> "Science centers, the community of not-for-profit CEOs and other communities such as science and math educators." ~ Science Center director.

> "Aquariums and zoos – the museum community in general. Non-governmental organizations, conservationists and non-profits." ~ Director of a global network of zoos, aquariums, and museums.

> "The museum community…evaluation and research communities, academics. Consultants in the field." ~ Director of Audience Research for a national museum.

"Public affairs community, informal education including public education videos and documentary films." ~ Independent film-maker

"Primarily, the environmental education community, but also communications – marketing and branding." ~ President of a national foundation.

"Youth development community, informal science community, political science and public policy communities." ~ Director of Research for a national youth organization.

Although only 5 of those interviewed specifically identified Informal Science Education as their community of practice without prompting, when prompted about their connection to the ISE field, all thirty-five reported that their professional community overlaps to some degree with the ISE community. Half (49%; n=17) were quite emphatic that most or all of what they do could be considered informal science education, stating that they were "definitely" or "absolutely" a part of the ISE community. Characteristic responses included:

"We were among the founders of ISE and are daily practitioners. It's not all we do, but a big part." ~ Director of a national youth organization.

"Yes, just by definition, we are a part of ISE. Radio is informal – it is how adults get educated; it's their source for information." ~ General Manager of a public radio station.

"My organization is part of ISE. There are a lot in our community who would not call themselves educators who are doing what we are talking about. There is a lot of school stuff too though" ~ President of a national foundation.

"Yes, most definitely. Documentary films are a motivating factor for people to seek more science education. We reach people in their homes to provide a basic introduction to issues and demonstrate the scientific method. That can lead to further learning in museums or other places. We can show them where to go to learn more." ~ Independent film-maker.

One person representing science writers who was interviewed felt that there was some overlap between her/his field and ISE, but "not a lot," stating that her/his community provides services to the ISE community, but were not a part of it. However, this type of response was not frequent.

The missions and goals shared by those interviewed tended to converge on just a few broad ideas centered largely on improving society. Mechanisms for accomplishing these goals included improving decision-making skills, helping to create a science literate population, improving quality of life, and helping people stay healthy. Specific examples included:

"We are trying to raise awareness of issues. The biggest motivating factor is to promote science literacy – theatres choose films to achieve this." ~ Film Association president.

"To illuminate society, to improve society and the environment. This is the 'only and all' of what science centers are about." ~ Science Center CEO.

"To create knowledgeable global citizens and to encourage young people into STEM careers." ~ Executive Director of a children's museum.

Several of those interviewed made the point that knowing about science is critical to everyday life – both to improve quality of life and support people being responsible citizens. One said, "In this age, our lives depend on knowledge. We need air clean enough to breathe, quality prescription medications, traffic lights that are programmed to keep people safe – everything relies on science and technology." Informing and inspiring the public by raising awareness, increasing interest and making connections between STEM content and the everyday lives of the public were very common responses. Encouraging youth to consider STEM careers and helping to promote environmental stewardship were also mentioned by several of the individuals interviewed.

Community of people and shared practices

After institution or domain, the most frequent response about the community with which they identified, related to the individual's perceived professional role and the shared practices in which they engage. A third of those interviewed responded with various forms of "educator" (e.g., educator, in general; science educator; environmental educator). Other responses included: after-school provider; youth development executive; scientist and broadcaster. At the end of the interview, research participants were asked to rate how closely they personally self-identified with a list of different types of educators (1 being *Not at All* and 5 being *Very Closely*); the strongest associations were with the communities of Informal Science Education and Public Service Provider (Table 1).

Table 1. Mean rating of self-identified relationship to educator-related terms; 5 point scale with 1 being *Not at All* and 5 being *Very Closely*.

Community	Mean Rating
Informal Science Educator	4.32
Public Educator	3.41
Free-Choice Learning provider	3.24
Public Service Provider	4.03
Science Educator	3.32

Even if they did not self-identify themselves as educators, a majority of those interviewed (54%) agreed that they acted as educators. Many of those who did not identify themselves as educators indicated that while many in their field were educators, they themselves played a more administrative role within their organization. This likely reflects the decision to include ISE leaders, all of whom we felt could represent the professional *community or communities* in which they participate broadly. Those interviewed were overwhelmingly in agreement (89%) that the professional communities/institutions they represented have educational missions. Indicative responses included:

> "Education is one of the last great mechanisms to improve society – it's a pathway to a better life." ~ University educational researcher

> "Yes, missions are increasingly education-centered. It used to be social and civic development, now they are more education-focused." ~ Program director of a youth development organization.

> "Education plays a central role – all of the museum is education. Every job in a museum should have an education focus." ~ Science center director.

> "Not totally, our community has a lot of academics; they all teach, but they do research as well. The education division definitely does." ~ Executive Director and CEO of a science society.

Only four individuals we interviewed did not give a definitive 'Yes' to the question of whether their community had an educational mission, but all four gave a 'qualified 'Yes' to the question:

> "We have an education mission, but not a school mission." ~ Director of Research for a national youth organization..

> "… *education* is a loaded term – our role is to inform; to raise awareness." ~ General Manager of a public radio station

> "there are many researchers in our community, but certain segments do education." ~ Executive Director at a science research institute.

> "We do education with a small 'e'. We don't give people facts, we entice them into the world of science – make it exciting, interesting, dramatic and beautiful." ~ [Head of Science for public broadcasting organization.

Justifying the community's role

In response to the question of to whom does their community need to justify the importance of what they do, those interviewed indicated that they most need to make a

11

case to policy-makers and funders; as one put it, "to those with money and those with power." The public was also named frequently. Typical responses included:

> "City officials, corporate sponsors and other funders, and the public" ~ Director of a global network of zoos, aquariums, and museums.

> "We need to make the case to the state and federal government, to policy-makers, to the people who don't come, but are interested, and the research community – academia – they mostly get it, but not entirely." ~ Audience Researcher in a national museum.

> "To funders, federal and private, and to future professionals – we need to let people know that there is a career here." ~ Executive Director, national environmental association.

We also asked research participants to discuss how they make a case for the importance of their community's work with the assumption that this question might reveal commonalities across the ISE community. Results suggested that the most effective arguments supporting their existence tie back to their institutional missions and relate to improving people's lives, fostering the next generation of STEM professionals and contributing to an informed and scientifically literate citizenship. Many stated that although data that demonstrate these impacts are most persuasive, empirical evidence for such impacts is often difficult to find. In many cases though, simple information such as demographics and numbers served can be effective in making the case.

There were many similarities in where professional communities seek funding, and most listed multiple sources including federal sources. NSF – ISE in particular, Department of Education, Department of Defense, Environmental Protection Agency, etc. were mentioned by nearly all participants in the study (97%). Corporations and private foundations were also mentioned by many (43% and 51% respectively); private donors were listed by just over a quarter (26%) and state government was named by 14%.

The most frequently mentioned obstacle to meeting the goals of the community was lack of resources – primarily funding. Another common theme was the "fragmented" nature of the community or the lack of a "united front." In order to make changes in policy and/or practice, several of those interviewed felt that the ISE community needs to coalesce around similar ideas and goals. Typical responses included:

> "Money, and not enough resources to rigorously prove impact; everything is still anecdotal. The lack of unity is also a huge hurdle – we need to work better together and for the same ends." ~ President of a national foundation.

> "The biggest hurdle is funding, but also the competition for leisure time. There is a fine line between entertainment and education, and people self-select away from science." ~ Science Museum director.

"Sustainable funding. The fragmented community, we need a common identity – we all need to get under the same banner. We need one field, not seven little ones." ~ Program Director of a youth development organization.

"Limited time and resources and the total lack of federal priority. There is also the assumption that health education information is being provided by others (parents, church, school, etc.); no one is taking responsibility." ~ Director of Education for a health education center.

Documenting the current ISE landscape

This research study's primary goal was to explore and document the current ISE community landscape. To do so we needed to understand who identifies with, and currently participates in that community, as well as who currently does not. We were also interested in the broad questions and issues members of this community believe they face and the tools they perceive they require to improve their practice and support their work.

Our working hypothesis was that if the multiple individuals and organizations that make up the ISE community are an effective CoP, we would be able to describe them as a group of people who share common goals and engage in shared practice through regular social interaction with each other through the vehicle of informal education. This was observed to some degree, but research findings did not fall cleanly within the three fundamental elements of CoP, perhaps indicative of the fact that this is a complex, multidisciplinary CoP, rather than a defined, more narrowly focused community. Although all engaged in communicating STEM to the public, interviews revealed that members of the ISE community primarily identified with the institutions within which they work, and/or through the specific media they utilize to communicate (e.g. exhibitions, print, film, broadcast and on-line media, lectures and individual-to-individual), rather than as a united field of practice. This was observed, despite the fact that all research participants to some degree identified themselves as engaged in a similar practice—being an educator or supporting the educational mission of his/her institution.

Given these findings, we visually represent these *qualitative* data by arraying the 17 communities sampled within a two-dimensional space, representing the strongest areas of identification observed within the sample (See Figure 1); connection to informal education as an educational process is on the X axis and the goal of promoting public understanding of STEM is on the Y axis. Since Figure 1is based upon a qualitative interpretation of a small sample of each of these professional sub-communities (i.e., the opinions of one to three individuals per community), it is important to appreciate that this is a preliminary representation of the ISE community as fits an exploratory study.

Although caution needs to be used when generalizing from these data, there are some interesting aspects to note which confirm our earlier hypothesis. For example, there is a strong cluster at the low end of the X axis – strong identification with informal education and a relatively strong association with the goal of promoting public understanding of

STEM which includes Science Centers, Natural History Museums, Zoos and Aquariums, and marginally Children's Museums. There is also a cluster at the top right – relatively weak identification with both informal education and promoting public understanding of STEM which includes Adult Organizations and Science Writers, and also potentially Youth Organizations, New Media Researchers (Note: the individuals sampled in the New Media category were both involved in educational gaming research which likely influenced their responses) and Science Societies. This cluster was primarily focused on formal education as an educational strategy, or viewed their community as only peripherally concerned with educating the public.

Parks and Gardens, Environmental Education organizations, Health Education Organizations, Extension and possibly After School Science providers (Note: the single individual sampled in the After School Science category represents a group that focuses specifically on STEM, and so results should not be interpreted as broadly representative of the entire "After School" community) form a potential third cluster that is more in the midrange of identification with both informal education and promoting public understanding of science. Public TV/Radio, Documentary Film and Libraries form a fourth cluster, which identifies more with informal education as a professional community, than public understanding of STEM, given that science is only one of many topics that they might focus on in their work. Although preliminary and exploratory, this visualization of the ISE landscape has already served as a useful tool to CAISE, and others in the ISE field as well as represents important baseline data with which to track changes in the development of the ISE community over time.

Figure 1. Two-dimensional representation of current ISE Landscape as a function of identification with informal education as an educational process and public understanding of STEM as an educational goal.
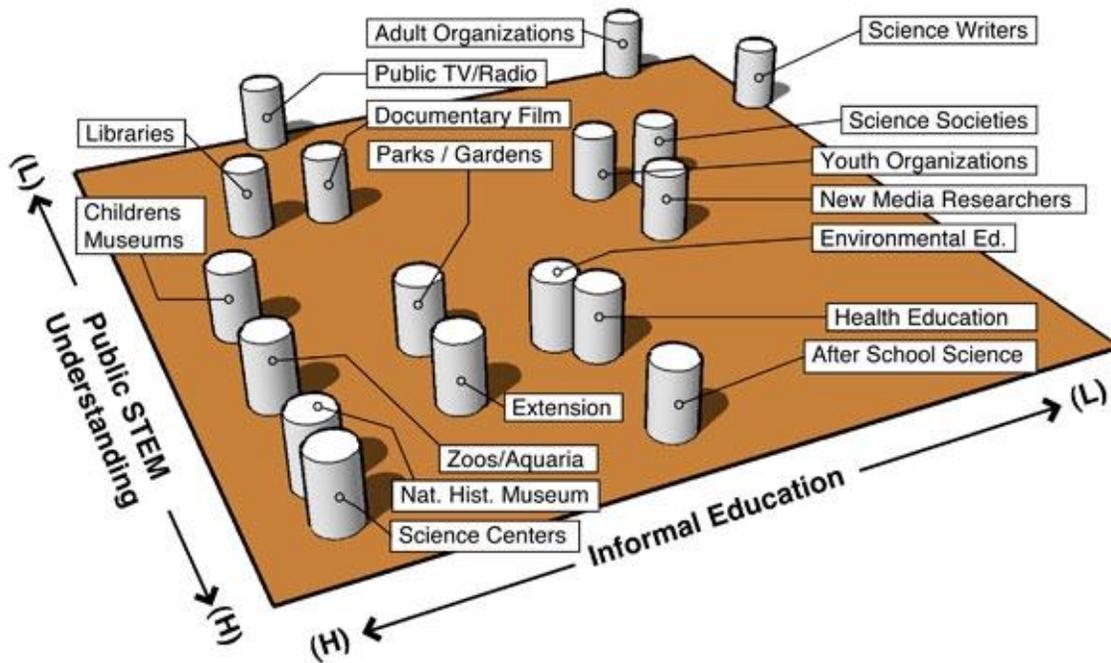
6.   Discussion and conclusions

We interviewed a diverse set of individuals for this study, each of whom was considered a leader within one of seventeen different types of professional communities, all arguably involved with informal science education. Without prompting, the vast majority of these individuals self-identified themselves first and foremost as being part of their immediate professional community (e.g. science center professional, writer, environmental educator, etc). When prompted though, a majority acknowledged that at some level they are also part of the larger informal science education community. In this latter regard, nearly all of those interviewed felt that the communities they represented closely associated with the goals of ISE, and nearly half were quite emphatic that most or all of what they do could be considered informal science education. Interestingly though, the various sub-communities represented in our sample positioned themselves differently with regard to the ISE field. Some perceived their community as "daily practitioners of ISE," while others perceived that their community was "a cog in the wheel of where people get their information regarding science." About 15% perceived ISE as only a small part of the much larger or more general efforts of their community. For example the environmental educators described their mission as conservation; they saw science as just one facet of that activity. Similarly, youth organizations saw their mission as youth development with enhanced science understanding being just one small piece of what they were trying to accomplish.

Disaggregating the two dimensions of the ISE CoP that all participants discussed to some degree – "promoting public understanding of STEM" and "practicing informal education" – enabled us to create a visual representation of the ISE community space.

Utilizing this analytical frame, some communities currently perceive themselves as tightly committed to the central tenets of an ISE CoP, for example, the Science Center, Natural History Museum, and Zoo and Aquarium communities, with Children's Museums as an outlier in this group. The Science Writer community, Science Societies, New Media Researchers and Adult and Youth Communities currently view ISE as more ancillary to their work. The remaining groups, such as the Broadcast Media community, Documentary Film Makers, After School Science providers, Parks and Gardens, Health Education and Environmental Education communities, currently perceive themselves as somewhere in the midrange on these two dimensions.

Based on the findings, it is fair to conclude that the broad assortment of ISE institutions that constitute the ISE field are not currently functioning as an effective and cohesive CoP, even a complex, multidisciplinary one. However, there are sub-communities that are participating more fully, for example, the organizational cluster that includes Science Centers, Natural History Museums, Zoos and Aquariums and possibly also Children's Museums, could be said to be functioning as an effective ISE community of practice. These four sub-communities currently have a strongly shared sense of mission and complementary subject matter focus, there is a cohesive community of people who care about this domain, and there are many commonalities of practice that are shared between them. Supporting this finding is the fact that there is a significant subset of members of these different communities who regularly attend the same conferences (e.g., Association of Science-Technology Centers, American Association of Museums, National Association for Research in Science Teaching, Association of Children's Museums), read the same journals (e.g., *Visitor Studies*, *Science Education*, *Curator*, *Journal of Research in Science Teaching, Museum Education*) and cross-hiring between the four sub-communities is common. However, participation in these shared social practices considerably decreases the further one moves beyond this "science museum-like" cluster.

That said, across the array of sub-communities sampled there were many examples of shared practice and ways of talking about the work of the community. Although each of the representatives of the various sub-communities positioned themselves quite uniquely with regard to ISE, there were four striking and important similarities between all groups:

- There was considerable agreement in the importance of promoting public STEM understanding and literacy.
- There was widespread convergence around the value of free-choice learning and commitment to the practice of informal education.
- By and large each sub-community seeks funding from the same pool of resources.
- Each sub-community uses very similar evidence and arguments for making the case for the value of what they do.

These findings suggest that the constituent parts of the ISE community do indeed share many common goals as well as engage in many shared practices It is probably fair to say that amongst our sample, no one categorically excluded themselves from the ISE community, with the exception of one individual who perceived that the community she represented was outside the ISE community. She described her community as being the

film/entertainment business with science communication/education as merely a convenient means to an end rather than a critical reason for existing. Although this person arguably should have been in a position to represent the views of the broader community she was selected to represent, how representative in fact were her views, or for that matter those of the others included in this exploratory study, requires further study.

However, to become an effective community of practice, participants from across the various sub-communities within ISE would need to choose to learn and advance their practice through regular interaction and communication within the community. Although interactions regularly occur within each of the sub-communities that constitutes ISE, there is currently little boundary crossing and linking of communities across the field; clearly missing was evidence of widespread, active relationships over time and organization around issues that matter to members of the broader community. Something seems to be preventing the various ISE entities from naturally coalescing into a fully functional ISE community of practice. We would suggest two possible hypotheses to explain why there is not already a vibrant, fully functioning ISE CoP.

Hypothesis One is that there is no historical, sustained need for there to be an overall informal science education community of practice and by extension, it is unlikely for there to be a need in the future. Although there are short-term motivations for collaboration and communication across the various sub-communities involved in informal science education, e.g., a grant proposal or promotional effort, these needs have been and could continue to be accomplished within existing networks and models of social interaction (e.g., personal networks and through as-needed working agreements). In short, there is no perceived value to justify the added expenditure of time and energy necessary in establishing and maintaining a more extensive, fully functional ISE CoP.

Hypothesis Two is that existing informal science education sub-communities have not become a more robust overall ISE CoP because they lack an overarching vision that enables them to recognize the significant value of such a community to the work of their individual sub-communities. In other words, it is not that the sub-communities are opposed to engaging in ISE CoP activities but rather that they have not historically or currently understood the specific value such a community of practice might afford. It is analogous to observing several communities of workers involved in different aspects of production in a single field ignorant of the benefits of collective bargaining. Thus, each opts to unilaterally approach management about improving their working conditions. The workers' decision not to engage in collective bargaining with management may not necessarily be construed as indicating that collective bargaining is an unproductive strategy, but merely represents a lack of appreciation by the workers of the potential value of collective bargaining. It is possible that an analogous deficit in understanding currently exists within the overall ISE community.

The data collected in this current study is insufficient to confirm which of these two hypotheses is most valid. However, clearly determining which of these two

"explanations" most closely maps with historical realities has significant implications for any future community-building efforts.

As within any complex system, the ISE community is not in stasis. Regardless of historical reasons for the current situation of the ISE community, the social, economic and political context of the ISE community is rapidly evolving; these changes rather than history are likely to influence which of the two hypotheses emerges as most valid in the future. For example, with the current global financial challenges, and increasingly shrill rhetoric about the importance of STEM education to national competitiveness, it is fair to surmise that the STEM education landscape is likely to change rapidly in the next few years. What is less clear is in what direction these changes are likely to occur. One could make equally compelling cases for wide-scale expansion of the STEM education infrastructure, as well as for widespread collapse under pressures to fund only "essential" services (e.g., health care, trash collection, police and basic academic skills like reading and computation).

The most likely future is one where the emphasis on STEM education increases, but the available funding for STEM actually decreases. We believe that this reality will significantly increase pressures on the constituent members of the greater ISE community to demonstrate their relevance and value to society. One outcome of this scenario would be a de-emphasis on informal science education and an effort by all current informal purveyors of science education to join forces with formal science education to present a united "STEM education front." An alternative scenario would be the development of a unified ISE community of practice where the benefits of cooperation across ISE sub-communities would be viewed as significantly outweighing the benefits of competition; ISE asserts its claim that it delivers essential, non-competitive science education services to the nation beyond that provided by schooling. Both scenarios envision a continuation of the current societal trajectory toward the breaking down of historical boundaries and silos (Castells, 1996; Gurian, 2010; Hill and Lynn, 2005), but each would move ISE down a very different track. Similar pressures in other sectors have resulted in comparable trajectories. For example in the science arena, societal pressures to develop innovative solutions to such large, complex research challenges as global climate change, have resulted in scientists working across disciplinary boundaries, some for the first time in their careers. It has also resulted in the rebranding of traditional groups of disciplinary based scientists to appear to be more closely aligned with societal concerns. The current crisis in the financial sector has similarly led to a combination of strategies – both the forming of new partnerships and collaborations, as well as to wholesale mergers and acquisitions. The key is that "crisis" can be a powerful catalyst for relationship-building and the breaking down of silos; of course it can also be a catalyst for retrenchment and reversion to "each one for themselves" behaviors.

Only time will tell which of these various scenarios is most likely to occur. In the mean time, this exploratory study does provide a preliminary snapshot of the current state of the ISE community; one we believe falls short of functioning as a multidisciplinary community of practice. Findings help to illuminate the current strengths and weaknesses of the ISE field, serve as a benchmark for future investigations of the field, as well as

provide some fundamental framing for those that hope to help support this insipient and growing community.

7.   References

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Appendix A

Study Interview Sample

Youth Organizations
- Forum for Youth Investment
- Girls Inc.
- National 4-H Council

Adult Organizations
- AARP

Science Centers
- Liberty Science Center
- Headwaters Science Center
- Lawrence Hall of Science
- Museum of Science

Natural History Museums
- Australian Museum
- Canadian Museum of Nature

Children's Museums
- Exploration Station
- The Children's Museum of Houston

Zoos & Aquariums
- Association of Zoos & Aquariums

Gardens & Arboretum
- American Public Gardens Association
- National Park Service
- New York State Parks

Environmental Education Organizations
- National Environmental Education Foundation
- The Ocean Project
- Albert I Pierce Foundation

Libraries
- Queens Borough Public Library

Public TV/Radio
- BBC
- Wyoming Public Broadcasting

Film-makers
- Giant Screen Cinema Association
- CineGroup
- ScienCentral Incorporated

Writers/Journalists
- National Association of Science Writers

Health Organizations
- National Association of Health Education Centers

Extension Service
- University of Minnesota-Twin Cities
- Regional Extension, Morris, Minnesota

Science Societies
- American Chemical Society
- Space Science Institute

Afterschool
- Coalition for Science Afterschool

New Media Research
- Harvard Graduate School of Education
- Pennsylvania State University

Appendix B
Study Interview Protocol

Thank you for taking the time to speak with me today. We are conducting a study to better define the landscape of professional communities that are involved in communicating science to the public. You were contacted because you are regarded as a leader in your field, and we are looking to you to help us better understand more about your professional community and more about what you do. We would like to conduct a short interview, asking you questions about your work. Interviews typically take about 30 minutes – there are no known risks involved in participating; however, there are no direct benefits to you either. Your participation is totally voluntary. You may elect not to answer any question I ask, or end the interview at any time. Do you have any questions? Will you take part in the interview?

1. I would like to begin by asking you to identify the professional community or communities you see yourself as part of.
    a. When you go to a cocktail party, how do you describe what you do?
    b. Who do you consider your colleagues?
    c. What journals do you read/write for?
    d. Where do you go to get funding?
    e. What are the key buzz words in your community that are important to use when seeking funding?

2. Do you think that the community/communities you belong to think of themselves as having an educational mission? Explain.

3. Do you consider yourself an educator? Explain why or why not.

4. How does your community/communities contribute to communicating science to the public? If not science, what, if anything, are you trying to communicate to the public?

5. What is your community trying to accomplish through these endeavors?

6. What are the motivating factors behind providing these services to the public?

7. What would you say are the big issues your professional community is trying to address or goals you think it is trying to meet relative to the public? Where does communication of science and technology fit into this?

8. In your opinion, what sorts of things are preventing your professional community from fully meeting its public communication goals, or getting done what it wants to do in this area?

9. What are some aspects around communicating in general and communicating science to the public in particular that your community is particularly good at? What are some areas where you could improve?

10. To whom does your community need to make the case that what it does in the area of public outreach/education/information [however they describe what they do] is important? Policy-makers? Funders? The Public?

11. How does your community make the case that what it does in the area of public outreach/education/information [however they describe what they do] is important? In your opinion, what arguments/evidence are most persuasive? In your opinion, what arguments/evidence are least persuasive?

I am part of an organization called CAISE, the Center for the Advancement of Informal Science Education which was recently funded by the National Science Foundation. The purpose of CAISE is to develop an infrastructure to support and improve the practice of informal science education by building a community of practice and advocating for broad issues of concern to the Informal Science Education community including research, funding and public awareness. As part of CAISE we will be developing a web site and monthly newsletter, organizing workshops and conferences, studying and documenting the critical and emerging issues in the field and providing fellowships and mentoring opportunities for those new to the field. The CAISE project defines Informal Science Education very broadly, including such things as: film and broadcast media, science centers and museums, zoos and aquariums, botanical gardens and nature centers, digital media and gaming, public health efforts, local, regional and national environmental education efforts, and adult, youth, community and after-school programs.

12. Do you think your community is part of the Informal Science Education community or not? [Explain] Where do you see overlaps?

13. What might some advantages and disadvantages of CAISE be to your own professional community?

14. What structures, resources, etc could CAISE provide that would benefit your community and its members?

15. Finally, I want to ask how closely you, personally identify with several professional communities. On a scale from 1 to 5 with 1 being *Not At All* and 5 being *Very Closely*, how do you personally identify with each of the following groups?

Informal science educators	1	2	3	4	5
Science educators	1	2	3	4	5
Public service providers	1	2	3	4	5
Public educators	1	2	3	4	5
Free-Choice learning providers	1	2	3	4	5