

# Transformations

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## Issue No. 26 — Thinking in the Arts-Science Nexus

### Reflections on Public Art + Science Reasoning

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#### Introduction

The art/science nexus has historically been approached through a challenge of aesthetics versus mathematics, and processes of knowledge production. Notably absent in this debate are the social sciences that explore human experience and perception. In particular, what has not been addressed clearly in the literature is how reasoning about the human experience can be provoked when people encounter content that does not assert itself as neatly defined in either an art or science discourse. By reflecting on one case study of a public art/science installation, we explore new fields of knowledge production. Our exploration found that the broader function of memory, metaphor, juxtaposition, and hypothesis generation were key to advancing public reasoning with science information. This study of the lived experience with an ambiguous installation that did not declare itself as either art or science provoked reasoning processes that required viewers to consider their relationship to the parts and the whole, to both question what they knew and understood from the work, and to question how science information is part of their lives. In doing so, we uncovered distinct paths of science reasoning once the viewer defined the stimulus as art. We were also led to reflect on the history of informal science learning pedagogy.

The case study in question was a three-month site-specific public installation work in New York City that strategically incorporated site-specific scientific information as a starting point for engaging with urban science questions. The work, conceived by artist Mary Miss, is part of a larger oeuvre that seeks to use installation to provoke critical thinking and activate discussion about the earth science and engineering decisions that shape a city. The larger endeavor is a long-term collaboration between Mary Miss Studio, the authors of this paper, and a cohort of collaborating scientists engaged with Miss' City as Living Lab non-profit. The work in New York was conceived as the first prototype for a series of site-specific hubs on Broadway that are intended to catalyze thinking about the future of the sustainable city. We also note that a second engagement by this team is currently underway in Indianapolis, USA.

For this study, the artist and her scientist collaborators challenged the definitions of traditional science education discourse, and how public engagement with science (PES) unfolds. The authors of this paper worked as participant social scientists both advising the project and documenting the impact and process to explore how an artwork occupation of a public park impacted public understanding of sustainability in urban spaces. The installation used a series of signs on bright green poles, mirrors, text, graphics and a cell phone contact for more science information, distributed throughout a small urban park bounded by streets and containing older trees and fences that prevent access to the green space. The work defied easy categorization as an artwork or science display. The artist led the conceptual design and installation, while we explored its effects post-installation.

This art/science hybrid was intended as a provocative public space effort to shift informal science learning away from the museum paradigm. The intentions were to consider science learning as a public experience of site-specific reasoning through situating the self in a city in the context of the content. The installation allowed us to critically examine the way place-based experience, juxtaposition of the reflection of oneself in the mirrors alongside snippets of science content in a public space, and prior understanding challenge knowledge production. In this paper, we explore *Broadway: 1000 Steps* (2013), the first experiment by Mary Miss (b. 1944) as part of her City as Living Laboratory effort, as a case study to map the mental processes invoked in the viewer as a result of their phenomenological encounters, and we consider that in relation to the potential role of art in science reasoning, and our own thinking about informal learning as a field of inquiry.

## Project Overview

*Broadway: 1000 Steps* is the first physical iteration in Miss's larger oeuvre known as City as Living Laboratory (CaLL®), a performance, installation, and conceptual art exercise that convenes scientists and artists in critical public dialogue. Miss seeks to create opportunities for reflection on issues of sustainability and to broaden the space for science learning through provoking encounters with science content through art in public spaces. Art in this instance is characterized as a catalyst that removes the barrier of the museum walls by creating opportunities for passers-by to encounter reflections of themselves and information about the sustainability issues of their urban ecosystem. According to Miss:

Mary Miss / Sustainability Made Tangible Through the Arts (MM/CaLL®) provides a framework for how the arts and sustainability can be linked in innovative ways to create cities that help us redefine how we live our lives, use our resources, how we communicate, educate, work, and collaborate. CaLL® conceives of the city as a laboratory where artists and designers collaborate with scientists, other experts and policy makers to create immediate experiential impact from research and planning initiatives. The goal is to make sustainability personal, visceral, tangible, and encourage citizen action. (Miss 5)

Miss's strategy is to curate an assemblage of short scientific explanations that reveal aspects of the city to create a constant space for learning. She uses content that is generally considered either concealed or difficult to decode as part of the city fabric. In this case study, Miss highlighted the text and language of science by placing it on green poles topped by standard security mirrors that allowed users to read the text printed in reverse and reflected in the mirror while observing themselves (Figures 1, 3, and 4). Miss's provocations take the position that artist-curated installations in public spaces draw public focus to the concealed systems – political and ecological – that shape our urban environment as a strategy for increasing discourse on environmental sustainability solutions. She suggests that increased awareness of the urban infrastructure will provoke dialogue about environmentally responsible development.



**Figure 1.** Installation view of *City as Living Laboratory for Sustainability in Urban Design*. 2013. Photos by Mary Miss Studio.

Princenthal notes that the installation discussed here is situated in Miss's larger body of work. She describes Miss's practice as liberating content traditionally reserved for the museum, whether art museum or science center, by creating an experiment in public meaning-making. The experiment proposes that the social production of knowledge related to sustainability in cities could inform the professional practice of urban design. As social scientists, we identify the artist as a visual thinker who seeks to catalyze conversation between scientists and the public. By drawing attention to built space and urban design, the artist connects urban space to natural systems. Miss's works join other examples of the city as a laboratory (i.e. *Laboratorium*) or museum-like experience that challenge how urban landscapes can expand understanding as part of the lived experience in cities (Obrist et al). In particular, it builds on Ross's premise that artworks critique dominant paradigms by invoking "a future" with artists shifting their roles toward socio-political activism through collaborations with communities and environmentalists. In this case study, we place emphasis on natural processes and time sequences as an extension of the *Laboratorium* thesis.

### **Critical Pedagogies in the Art and Environmental Science Nexus**

To date, the majority of research that has focused on art/science intersections has placed relatively little emphasis on the socio-cultural ways users engage with science knowledge production (Veikos). It has tended to characterize science learners as an undifferentiated public rather than the plural publics, sub-populations embodying different experiences and uses for science in daily life. We suggest that this general omission of a heterogeneous set of publics created an open terrain worth considering through a constructivist lens (Charmaz). We used Miss's installation to explore the installation with passers by, how they used the provocations, and as a strategy for considering the construction of science knowledge. We were particularly interested in those who do not frequent science centers and museums, and those with disciplinary knowledge of the issue.

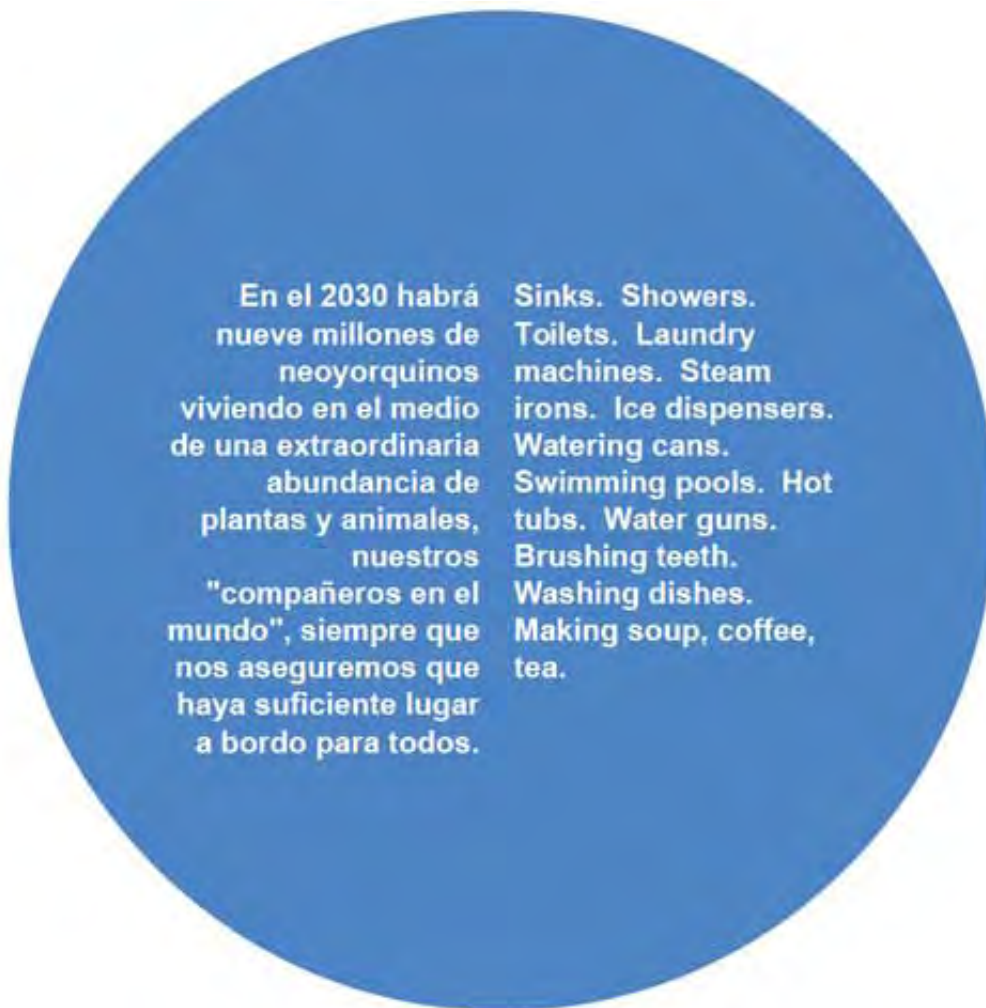
The traditional method for citizen engagement has been public meetings; short bursts of intense workshop-style collaborative community design and planning processes where designers and planners work with local stakeholders to create shared solutions. Successful inclusive public consultation, however, is seldom achieved. Research into public process demonstrates that competing narratives and frames of reference curtail creativity, polarize debate, and often fail to

accomplish the goals they set out to achieve (Halvorsen; Webler, Thomas and Tuler; Webler, Tuler and Krueger). This failure has been attributed to the lack of public understanding of successful models and experts' inability to appreciate the language and discourses of a general public who have neither their specialized training, nor have they developed the thought processes required to engage in that debate (Horst; Vygotsky). Miss's efforts suggest that artists may provide a bridge that can activate more informed dialogue through prior experience with an artwork that allows the public to find their place in the content. She suggests that these encounters in advance of any public meeting or purposeful engagement can establish a common concourse for future dialogue.

Working with Miss's installation as an artifact, we employed a constructivist grounded-theory approach (Charmaz; Strauss and Corbin) to explore how city residents had first-hand experience with using the urban systems created by engineers, planners, and government policy makers and how they build understanding of the macro-impacts of their environmental choices. As researchers, we recognized our own questions or doubt as central to the construction of knowledge; that our intervention caused knowledge production that might not have occurred without involvement of our survey team. And we acknowledged our survey strategy using a simple laddering technique that asked passers-by to serve as confederates in our study (Reynolds and Gutman). We asked what they thought of the work, and why that was so, to develop an understanding of how they translated the attributes of the installation into meaningful associations with respect to themselves. In effect, we worked with our research participants to develop critical inquiry into their thinking about the installation without description or categorization by our survey team.

To accomplish this goal, we took the position that art installations in public spaces can allow the public to focus critically on various aspects of the systems that support their lives and are more likely to increase literacy surrounding positive environmental sustainability initiatives. Our position in this inquiry was that artist-curated experiences are more likely to produce active public reasoning about environmentally responsible urban development. In contrast to more constrained science education pedagogies that focus on narrowly constrained prescribed learning outcomes (Pekarik), we suggested that reasoning is a more open-ended exploration of prior understanding and beliefs. Therefore, we looked at various actors including the artist, disciplinary specialists in urban design, and neighborhood passers-by to explore how directed attention could influence informed decision making about infrastructure, planning, and policies that support the biota on which human life depends. Miss's tactics suggest that showing people factual scientific descriptions in a public installation might influence thinking about how their choices in transportation make a difference in their neighborhood's air quality, for example, or how a roof is part of a river watershed, or how energy use is linked to mountain-top removal.

This art/science collaboration challenged the conventional spatial boundaries of destination museums with paid admission by situating the project in a well-traversed "pocket-park" in a dominantly working class Hispanic neighborhood in the direct path between public transit and City University New York's (CUNY) City College main campus in Manhattan. The installation of 61 lime green poles holding images or text and mirrors did not have the structure of a traditional art object. It also challenged the conventional disciplinary boundaries of scientific display by not revealing the signs or using explanatory diagrams (Figure 2). For example, a provocative sign reflected in one mirror behind a blue sign with the word Water said:



**Figure 2.** Water text from installation as it appears in a mirror. *Broadway: 1000 Steps*.  
Image by Mary Miss Studio

In another instance, the artist arrayed the mirror to reflect a maintenance hole cover with a color ring surrounding it, and a corresponding color panel with the word "Energy" facing the viewer, and a reflected image of an electrical generating station reflected on the back of that sign. The viewer saw themselves, the generating station picture, and the maintenance hole cover all aligned side by side. In no case did the artist seek to define a specific learning objective, but rather an arrayed set of issues that remained open-ended and ambiguous.

As a whole, the project challenged the informal science education orthodoxy of prescribed learning "outcomes" as the prime measure of knowledge production as has been suggested in many federally supported frameworks (i.e. Friedman). Outcomes evaluation has been criticized as particularly stifling to innovation in informal science learning environments (i.e. Pekarik, Doering and Karns; Bartels et al). Pekarik in particular notes that knowledge-based outcomes "restrict autonomy, creativity, and even diversity of programs in informal settings" (Pekarik 165). But this is a critique of the dogmatic tyranny of knowledge where the outcomes have been simmering for more than 15 years. As far back as 2002, Ede has suggested that the use of the arts as a means to encounter science in the public context is a provocative shift in the dissemination of content (Ede).

As such, the installation we discuss here became a provocative effort that required an engaged viewer to make meaning from the puzzle of more than 100 small images, texts, mirrors and subtle markings arrayed across the entire park. The artist sought to engage dialogue directly with a community. Our efforts were to surface the thought process by engaging the passers-by in observation, reasoning and discourse to learn how science reasoning emerged naturally. We did not test for knowledge transfer, but rather, sought to understand how science reasoning was situated in culture and everyday life (Fraser and Miss). We sought to explore a social theory of

knowledge production (Goldman) whereby the effort of the artist aims to appeal to an individual's prior experiences, and use of juxtaposition to direct inference. This was a strategy that our team of artists, scientists and researchers suggested would allow for deeper and more profound learning outcomes than traditional science interpretation.

It is this interpretive level "street-art" experience that we explored as a new tactic for increasing science literacy around sustainable choices. We conceived of the hybrid art/science encounter as a reflective practice that would increase participation in urban design policy decisions.

### Informal Science Learning

There are two principal areas of difference between formal classroom science education and what is known about out-of-school, non-formal science learning where experiences are pursued by the free choice of the learner. In summarizing the non-formal process of learning, the National Research Council's report suggests that there are six primary modes of knowledge production in free-choice settings (Feder et al). Three of the dominant modes in the NRC report rely on deductive process including exploration of meaning, concept acquisition, and participation in the scientific enterprise. Two of their categories have a much greater overlap with art consumption related to the future-oriented abductive and inductive processes of hypothesis generation and the reasoning processes related to describing the truth of a phenomenological experience. The sixth, and much more controversial, strand is identity development, this latter construct representing the reflexive mental process of executive function; the reflexive anticipated outcomes from self-presentation in a given context.

For this case study, we typify non-formal science learning as knowledge acquired through encounters in daily life. These encounters are likely to be culturally specific and localized. We suggest that museums as informal learning centers are not genuinely free-choice, but a hybrid form of non-formal/formal learning because they tend to be organized around a dominant pedagogical frame, have admission fees that exclude some classes of people, and have architectural presence that confer authority on any claim made by the institution as a representation of the dominant cultural perspective. That is, their form sanctions specific knowledge-work as correct. Museums tend to ritualize forms of information consumption and prescribe knowledge production for audiences. All museums inform the user about what is to be consumed and determine what experience outcomes are suitable (Pekarik, Doering and Karns). Art museums invite art explorations, whereas at science centers an art display is subject to the dominant concept that science is the *a priori* pedagogical frame that visitors are invited to employ in decoding meaning.

Bartels et al. (2010) suggest that much of the science learning discourse has relied on reductionist approaches that isolate types of learning processes as separate ways of thinking as typified in the Feder and colleagues National Research Council 2009 report, rather than a synthetic endeavor that is more true to the range of reasoning experienced by learners. They suggest that the prior knowledge and cultural variations in informal experiences offer more potential for serious and sustained learning in informal environments (Bartels et al 168).

We acknowledge that our study at the intersection of art and science is not a new strain of exploration, but rather builds on work from the 1990s that sought to better characterize the process of knowledge production relating to science. Unfortunately, most ISL research has been conducted in structured science learning programs like museums with a quasi-formal structure to the interventions, and therefore do not necessarily reflect current understandings of the scientific thought process, or of how various publics grapple with the nature of science. By embracing and examining the concepts of science in culture and the cultures of science, public art has a role that is central to reinvigorating public discussion on numerous topics concerning science knowledge in general, and not just those limited to sustainability. Most exhibitions of science information within museums do not often include an artist's interpretation of scientific information. *Broadway:*

*1000 Steps* as a case study is an example of a break from formal science learning that allows for knowing science in the lived urban environment by inviting intentional or happenstance participants “to interrogate his/her assumptions” about knowing science and science in their daily lives (Geismer 25).

### **Aesthetics, Art, Science, Learning**

In efforts to reach broader audiences in multiple contexts, artists, scientists, educators, and museum professionals strive to continually re-imagine, create, and articulate innovative ways for publics to explore science within their culture. “History demonstrates that the interchange of inspiration and ideas between art and science has always been fertile soil for innovation” (Stein 23). Broadly speaking, the socio-cultural understandings of science that already exist, or their potential understandings, are shaped by the affordances already embedded in the cultural histories that collide when new communities seek to make shared meaning. We suggest that this is the field where Foucault’s “subjugated knowledges” applies to this study. As Dolson (2009) describes Foucault’s idea (1980):

Foucault further explains that subjugated knowledges are, unlike their official counterparts, inchoate, naïve or non-hierarchical knowledges or modalities of apprehending the phenomena of the world and acting upon it – they are, perforce, highly plastic in that they lack any formal centralisation, and thus connect, de-connect and re-connect according to the situation at hand. And, as such, they need to be understood or revealed from below – through the interstices of the socio-cultural systems through which they circulate. (Dolson 57)

These efforts to know the cultural systems that subjugated “local” and “scientific” knowledges flow through or are produced within, have proven to be central to communicate the methods and products of science, the culture of science, and the ways scientists think and work together, and in turn how artists relay this information. Miss attempts to embrace this notion in her use of science facts juxtaposed with environmental conditions. She elects not to interpret factual data through her art, but rather, to use reflection to place the viewer alongside an environmental fact such as storm water outfall or trash receptacles, and scientific statements to test their need to reconcile their image with the content. It is this juxtaposition that encourages negotiation of science as part of the self and culture.

Dewey suggested that art is an aesthetic experience that offers a sense of wholeness or completion. This supposition has long been challenged by environmental, landscape, place-based, and performance artists in the latter twentieth century (Krauss). These artists challenge wholeness by creating ambiguity and experience as a puzzle that lacks finality, that lacks designated limits. Miss’s exercise in public art encourages the use of public space as a negotiated terrain for cultural learning or reconciliation. It is a space of open-ended reasoning that allows for hybrid thinking. It is this aspect of the scientific process of hypothesis generation that is both socially and culturally specific. This process falls outside of sanctioned learning environments that challenges deduction, speculation on limited data, and inference that is provoked but not predicted by small intersections of understanding. This interdisciplinary arena has created an open dialogue between museum studies and education discourses that tend toward exploring disciplinary intentionality, the disputed theory of outcomes rather than an expansive consideration of cultural discourse, aesthetic experiences, and the construction of literacies in public audiences. It is this tradition that Stevens uncovered through study of how more abstract memorial installations are interpreted by users as emotional hedonistic celebrations of usership rather than inviting decoding or debate about their content. Our observations of Miss’s installation suggest that hedonistic reasoning processes can be invoked in the presence of scientific facts, but do not preclude integration of those facts in larger life processes.



**Figure 3.** Using mirrors to decode or for personal assessment. 2013.  
Photo by Mary Miss Studio.

### Shifting Paradigms: Evaluating The Nature of Science (NOS) & Science Learning in Public Spaces

As we consider the ideas offered by the passers-by and disciplinary specialists interviewed for this project, we have come to believe that the art/science dialogue can open new ways of considering the social and cultural reasons for learning science. By reviewing our own notes, and the journalist's interviews with Mary Miss, we learned that she believes her art reveals a greater localized understanding of the social and cultural experiences of science knowledge (Princenthal). This suggests that it is possible to explore the socio-cultural meanings and values of science that can shift thinking about how non-formal science learning is relevant to different publics. As a result of these reflections, we challenge how Public Engagement with Science (PES) has been explored to date. Miss and her contemporaries offer both ISL and PES researchers distinct ways of reconsidering the cultural factors that shape a heterogeneous collective of publics as they negotiate meaning through art and randomly organized science facts.

Informal science education is rooted in formal education theory. It assumes a teacher, be that a person or a curated sequence of objects or signs, synthesizing disciplinary expertise and sharing it with an unknowing general public. Informal science tends to assume that an artifact in context can deliver a clear story. Museum label writing studies have focused on direct transfer of information based on brevity and an *a priori* predisposition for science inquiry (i.e. Screven; Serrell). Adopting a focus on cultural specificity suggests that there is no common agreement on artifacts of meaning. As Lederman and colleagues write, science is "tentative; empirical; theory-laden; partly the product of human inference, imagination, and creativity; and socially and culturally embedded" (Lederman et al. 499). But Miss suggests that there is orthodoxy in science communication that does not accept the culturally embedded knowledge. The facts laid bare in this case study are assertions, quotes or images like the juxtaposition of overhead electrical wires in the foreground with a reflected image of a nuclear power plant that evoke science reasoning that is unique for each viewer. In our interviews with participants, there was no right or wrong in this case. There was only a negotiation of cultural meaning, intention and hybrid speculation on



what ought to be for others, or is reconciled in what a person claims they do by moral right.



**Figure 4.** City as Living Laboratory for Sustainability in Urban Design. 2013.  
Photo by Mary Miss Studio.

Comparing art practices to science discourse, Goldman suggests that artists take liberties to imply connections without claiming predetermined outcomes, whereas scientific reasoning tends to build on layered inference. The collaboration with Mary Miss allowed us to explore how pedestrians decode juxtapositions. Review of our interview transcripts suggests to us that reasoning about the nature of science is socially and culturally embedded but not easily pinned down or statistically validated due to differing epistemological and ontological perspectives that emerged naturally in discussion with our interviewees. Issues such as realism or constructivism were not simply theoretical constructs, but were embedded in some passers-by's speculation and reasoning process. These publics were more sophisticated in their pedagogical position and challenged our need to lump and group ideas based on any ability to process a fact.

Our observational data suggested that pedestrians tended to engage with no more than two or three signs at any time, choosing to select one or two before leaving the space. Seldom did we witness an attempt to experience the whole work during a single visit. Survey data confirmed that the majority of people traversed the park on a regular basis. Ninety-two percent of the 300

passers-by observed by our team were observed interacting with intention with at least one part of the installation, and 68% of the 116 adults intercepted for our open-ended discussion claimed that they read one or more of the labels. We noted that there was a progressive increase in number of reading claims per day over the six weeks we collected data. These results confirm that the installation captured the attention of the park community. Consistent with most open-ended queries about an art installation, most participants first volunteered literal descriptions of a physical feature rather than the content in the signs. Further laddering questions that asked them to describe the installation to others, led them to struggle with reconciling the meaning or purpose of the installation to their own prior knowledge. These struggles to find meaning surfaced important information about how science and art thinking are part of the civic experience.

One aspect of these interviews that lends itself to further inquiry was the discovery in our data that public responses were more complex and informed near the end of the installation's life when compared to the first few days. These results suggest repeated exposure led to a new cultural meaning that was both part of the community understanding, but also invalidated the idea of quantitative measures of learning outcomes because time and frequency of exposure reduced the number of participants below the level needed for statistical analysis. The findings suggest that duration of an exhibit in public space does not conform to outcomes tyrannies, and that scientific treatment of exposure is central to understanding the value of a cultural intervention. In essence, even though we collected what would appear to be statistically useful data, the elapsed time and cultural uniqueness of each participant reduced the dataset to a qualitative comparison of experiences.

We suggest that the public experience of an exhibition in the ecotone between science and artwork allowed us the opportunity to explore science reasoning as part of life experience. It allowed us to explore the moral and ethical implications of science information impact daily life. As Jean-Marc Lévy-Leblond notes "[s]cience is adopting a human face. Through art it is entering the world of culture and sensitivity" (Lévy-Leblond).

### **Public Engagement with Science (PES)**

Public engagement with science (PES) is the descendent of the science literacy movement of the 1980s and 1990s. Measuring the public's science literacy grew out of the 1985 Bodmer Report (Royal Society) that called for investment of resources into bettering the public understanding of science. Durant, Evens, and Thomas (1989), as well as Thomas and Durant (1987), for example, developed a survey of basic science questions which they administered to members of the public in both the US and Britain. This survey was used as the basis for continued surveys of the public's scientific literacy. Several variations of this survey have come to be known as "the Oxford Scale," a model used in the US and Britain to measure public scientific literacy across countries. This concept of science literacy has drawn criticism from science communication and education scholars for its failure to adequately address the ways publics engage with science (Stockmayer and Bryant). In many instances, questions require those who take the survey to recall information that is not part of life outside of school. Some questions also presume that science is learned without social context. After years of study, results demonstrate that scientists have almost as much difficulty with the survey as the general public because many questions are outside their area of disciplinary expertise or lack specificity (one scientist remarked that the trouble was knowing too much, not too little, to answer correctly) (Stockmayer and Bryant).

Critiques of the Oxford Scale survey persisted into the 1990s and led to the first notable shift from focusing solely on general science literacy to focusing on the understanding process and development of positive attitudes toward science. This new approach still retained a deficit structure, with a focus on measuring progression from naïve to expert mastery of content. This new approach seemed to assume that greater understanding or improved attitudes would lead to greater appreciation of science. The approach assumed that science could be packaged and sold as a consumer marketing and public relations exercise (Bauer, Allum, and Miller). Embedded in this

approach to science literacy and the public understanding was a top-down rhetoric that separated expert from a general lay public.

In the early 2000s, science communication researchers began to question the top-down approach. While science remains tentative and builds on prior knowledge, notable enthusiasm with new scientific advances in the twentieth century such as X-Rays to measure shoe size, or use of fire retardants that were soon understood to be carcinogenic, fed a public narrative that science is not always to be trusted. It had become apparent that promoting understanding and appreciation would not be successful when the public was mistrustful of the science (Leshner). A new engagement paradigm attempted to reframe science communication as a two-way discussion between experts and publics.

This shift was noted by Joss (1999) as the incorporation of public opinion into the shaping of policies regarding science and technology. Unfortunately, the legacy of the deficit limits a public voice in the policy-making process; often perceived by both disciplinary scientists and those invited to learn as empty gestures meant to bolster support for decisions.

It is this gap in how different people engage in knowledge production that has emerged as an interesting field for experimentation by artists and scientists willing to set aside their assumptions of deficits. We see in Miss's proposition (Fraser and Miss) that the work is intended to provoke negotiation of meaning, to encourage a more open-ended exploration of how and why civic engineering infrastructure relates to perceptions of sustainability. Miss's presentation of facts removed the debate over expertise by introducing visual tension between images of urban resources and scientific descriptions of process fact. The occupation of public space with information promoted public engagement as a private sphere negotiation between a passer-by and their own knowledge. Miss also choreographed a few public events such as a recipe exchange and discussion tables where science experts might chat with those passing by (Figure 5).



**Figure 5.** Public dialogues at the installation.  
Photo by Mary Miss Studio

An artist's ability to direct the gaze toward scientific information without claim to a predetermined outcome may more productively engage a community in scientific reasoning. Pedestrians' experience with no more than two or three signs on any visit to this public display could be considered a more luxurious way of coming to know and process information. When considering the definition of art and science, however, our open-ended laddering discussions with 116 pedestrians found that most people were very literal, describing the physical features rather than the topics covered in the signs. These results did not vary if the discussion was

conducted in English ( $n = 81$ ) or Spanish ( $n = 35$ ). When asked how a passer-by might describe the installation to someone else, most struggled to reason through the meaning or purpose of the installation. They felt the need to define it as either art or science before they could offer thoughts on its meaning, with 17 people (14%) claiming, *"I don't know what it is,"* while the others were equally divided, with 46 people of the 99 confirming it was an art installation, and 53 claiming it was intended to teach science. These struggles to find purpose and then meaning suggests that while we may seek to find the theoretical middle-ground between art and sciences as thought process, the public is more likely to need the term in order to decide how they might choose to decode the meaningfulness of an artifact outside the pre-authorized topics conferred in a museum setting or school. We were heartened, however, to discover that over the three-month life of the exhibition, the level of discourse and knowledge brought to the discussions became more complex and delved deeper into the meaning of the information, even though our participants were evenly distributed by socio-economic status and formal education attainment. These latter findings suggest that Miss' exploration of the hybrid space between art and science did provoke public knowledge production and science reasoning for most people.

### **Bridging Paradigms**

There are clear links between informal science learning pedagogy and theories related to Public Engagement in Science. Rennie and Stockmayer considered public understanding part of ISL; they defined community science learning as a strategy for increasing science literacy through shared learning by scientists and publics, a topic reiterated by McCallie and colleagues in 2009. Work to advancing pedagogy in science education, ISL, and PES has generally sought to better understand what is required to engage various publics in science knowledge production and support scientifically informed decision-making. Despite this conceptual definition and positive findings from psychological research into constructivist approaches to scientific understanding (Fensham and Gunstone; Wheatley; Yager), few studies have been undertaken that allow for as open-ended negotiation of knowledge as this experiment. Our case study suggested that a more open space to explore the intersection of art and science rather than prescriptive learning outcomes is a valuable field for knowledge production.

Exploring this public installation in the conceptual hybrid space between art and science challenges the relationship between publics and purveyors of science information. Both ISL and PES scholars cite a variety of reasons for teaching science often embedded in economic advancement, utilitarian public goals for healthier lifestyles, or ensuring that a generalized public has the technical capacity to engage in scientific reasoning about policy decisions, or uses scientific information to guide their own personal choices (Millar; Stockmayer and Bryant; Turner). In general, however, the humanities implications of these calls for increased science literacies leave the social and cultural foci underdeveloped. Both Turner and Millar conflate the relationship between science and culture with an appreciation for major scientific achievements rather than cultural production of knowledge that absorbs findings from disciplinary science in ways that are purposeful for the user. When science content leaves the science center cloister and engages people in public spaces, the locus of power shifts from the scientist to the cultural production of knowledge with all its ethological complexity.

We see from this exploration that Miss' installation disrupted the daily pattern in ways that provoked observers to become consumers of information, challenging themselves to reconcile meaningfulness and utility. Without the cultural baggage of a museum, the exhibition challenged consumers to occupy the work – to decode it from within. Miss has added a subtle layer to an existing space in a manner that produces dialogue because it is not evidently art or science instruction that assumes a deficit in the learner. The need to label and codify uncovered by our discussions became a chance to produce cultural knowledge, either following a deductive path as nearly half of our interview participants did, or more abductive and inductive reasoning as the other half did. We note that this distinction in reasoning type remains consistent with the domains necessary for engaging in the full range of scientific thinking (Haig).

Seldom did our interview participants second-guess their label once they selected a category for the work. Once labeled, the category informed future assessments of what the artifact accomplished and there remained little doubt as to the purpose of the installation. What we found most interesting in their inference was the relationship between deciding the installation was art, and then considering its implications on personal behavior in support of sustainability. If they determined the installation was a science exhibit, most interviewees were quick to use a deductive process to describe what others ought to do to support sustainability.

We suggest that work that lives in the hybrid space of public art and science communication opens up new questions about *how* we choose to know and make behavioral choices as informal science thinkers. We find that an art definition can play a role in our cultural negotiations of sustainability, whereas science might be considered prescriptive information for those who adhere to lower moral codes than the person interpreting the work. We suggest that this case study challenges the limits of how we describe ISL in the cultural production of knowledge. We propose that the humanities frame helps shape inference in a non-threatening way as part of a complex web of moral, ethical, emotional, and intellectual pursuits.

### **Conclusion: Ways of Knowing, Engaging, and Evaluating**

This case study provoked a much broader critique of how distinct publics find utility in their scientific inquiry. It offered us the opportunity to re-think the orthodoxy of how public engagement negotiates the space for themselves in the scientific enterprise of sustainability strategies. And as Haig (2005) suggests, it opens up a richer field for inquiry that has been suppressed by deficit models of science instruction as permitting only deductive processes.

Our collaboration with Mary Miss offered the opportunity to map a new space for public engagement in urban spaces. It also allowed us to recover the value of abductive reasoning as part of informal science learning. In these instances, science information is integral to relating to relevant knowledge acquired through lived experience. In this case study, Miss sought to explore how public art can reinvigorate public discussion about sustainability. Our work suggests that an art/science occupation of public space opens up much larger understanding of knowledge production. By considering the cultural legacy of informal science pedagogy in the context of this installation, we suggest that ISL practitioners will benefit from challenging their practice by considering the work to be cultural dialogue rather than transfer of knowledge or engineering an attitudinal adjustment. We suggest that there is need to critique the underlying theology of knowledge deficits that support outcomes-based assessments. Rethinking informal learning means, in part, rethinking how the public can choose to engage in shared cultural production of knowledge with science.

To rethink the culture of science through lived experience is to rethink science as a way of knowing. Scientific knowledge, while highly valuable and shaped by critical thinking, is also situated within disciplinary social structures. It is possible that defining objects and information as art liberates learners and allows them to engage in critical thinking that is not divergent from science reasoning, and ultimately may help the science become more useful to a broader range of learners.

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