



## Supporting the Implementation of NGSS through Research: Informal Science Education

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The informal science education (ISE) sector is diverse and supported by entities as disparate as science centers, science in the media, afterschool programs, maker spaces, and hobby clubs. Consequently, it offers a wide and varied range of learning experiences – often with different audiences and goals than the formal sector. Although it is often assumed that school is the primary place in which learning occurs, a growing body of evidence suggests the important role that other settings play (Alexander, Entwisle, & Olson, 2007; Downey, Von Hippel, & Broh, 2004; Falk & Needham, 2013; OECD, 2012). ISE providers are a critical aspect of a healthy educational ecology required to support the learning of science. Indeed, for many learners, particularly those in the early years of schooling, informal experiences can represent a significant portion of their exposure to science (Bell, Lewenstein, Shouse, & Feder, 2009) and a compelling (and sometimes initial) points of engagement with science. Further, informal experiences play an important role by supporting the development of dispositions, skills, practices, and knowledge that enable students to succeed in science learning (Dorph, Schunn, Crowley, & Shields, 2012). Importantly, many informal science institutions (ISIs) also pay close attention to engaging communities currently underrepresented within the STEM fields.

Although collectively the informal sector serves audiences of every age, many informal providers focus on school-aged children and are interested in learning outcomes that significantly overlap with those of most schools (Falk, Osborne, Dierking, Dawson, Wenger, & Wong, 2012). Many ISIs engage with teachers and schools in multiple ways (e.g., professional development for K-12 teachers, field trips for K-12 students, after-school and summer programs for school-aged children) and could benefit from closer coordination with the goals and outcomes of the NGSS. While much of the efforts of ISIs to engage school-aged learners are place-based, occurring within their own institutions or settings, many have long histories of working with K-12 science leaders and educators to provide in-school programs and support for teachers, schools, and districts (CILS, 2005). Over the years, many successful formal and informal science education collaborations have been established. However there is still much that each sector can and should learn from each other.

Given the role played by the informal sector in training and supporting educators and science learners within the formal sector, how might the informal sector respond to the NGSS? We answer this question by considering two further questions: (1) *In what ways is the informal science education sector positioned to engage with and support NGSS?* and (2) *Where are points of mismatch between NGSS and ISE?*

### **How can the ISE sector engage with and support NGSS?**

The ISE community is exceptionally well positioned to support efforts to help children learn science both inside and outside of the classroom in the following ways:

## **Field Trips**

A common and obvious intersection between ISIs and schools are field trips. School trips to science centers, nature areas, zoos, aquaria, labs, etc. are common; most educators consider these to be worthwhile experiences (Anderson, Kisiel, & Storcksdieck, 2006; Cox-Peterson, Marsh, Kisiel, & Melber, 2003; Kisiel, 2005). Field trips have the potential to situate learning within a rich and appropriate context that provides opportunities to engage in many of the practices of science and give meaning to this important and innovative element of the NRC *Framework for K-12 Education* (2012). The time and money involved in transporting children outside of the school is compensated for by the significantly enhanced opportunities for engagement in the eight key practices of *NGSS* within novel and relevant contexts (Bell et al., 2009).

## **Professional Development & Curricular Materials**

The ISE sector plays an important role in professional development (PD) for teachers who teach science. For example, in one survey, the majority of ISIs (59% of all ISIs and 81% of Science Centers) provided science professional development for K-12 teachers (CILS, 2005). A majority of K-12 teachers report that the science-related PD they get from ISEs is of higher quality and greater usefulness than that of other comparable PD (Dorph et al., 2007; 2011). Collectively, the scale of this work is quite significant (CILS, 2005). Since ISIs are already engaged in PD activities, and have a reputation for doing it well, they are well positioned to provide PD that supports the implementation of *NGSS*.

ISE also have a long-standing tradition of developing curricular materials, including some of the most widely used school curricula in the country. Notable examples include: Engineering is Elementary, Building Math Curricular Project, Full Option Science System (FOSS), Great Explorations in Math & Science (GEMS), and Science Education for Public Understanding Program (SEPUP). A majority of ISEs also provide online science material support for teachers. Insuring that these and future curricular efforts by ISIs support the teaching of the *NGSS* is obviously a critical way in which ISIs can support the implementation of *NGSS*.

### **Where are points of mismatch between *NGSS* and ISE?**

There is more to science than the set of disciplinary core ideas, the 8 practices and the cross-cutting concepts of the NRC Framework (2012). The *NGSS* represents a significant improvement over current standards and breaks new ground, but it does not represent a complete set of practices nor a comprehensive view of what is involved in effective science learning experiences.

Not surprisingly, the *NGSS* frames learning within the structure of formal schooling – even-aged cohorts of children, moving through tightly controlled time frames, required to learn strongly defined and demarcated subject-specific content. In contrast, the world of informal science educational environments more closely mirrors normal life – mixed aged cohorts involved with only limited time constraints with individuals engaged in learning content by and large of their own choosing (Falk & Dierking, 2002). The dominant goals of many informal education providers are stimulating learner interest, curiosity and wonder about natural phenomenon, and promoting lifelong engagement in free-choice science learning (Bell et al., 2009). Such outcomes are only dealt with peripherally in the current *NGSS* even though they are commonly professed

to be important by many working within schools. Two particularly critical mismatches between the *NGSS* and ISE are the needs and interest of learners, and the potential misalignment between *NGSS* assessment and the focus of ISE. From this perspective, ISEs offer a set of alternative on-ramps for young people to engage with science.

### **Needs & Interest**

Life generates questions, needs, and interests that are not completely satisfied within school settings. Although it is common to think of the informal science education primarily in terms of structured experiences at venues like science centers or hour-long television shows like *NOVA*, in actuality most informal science education occurs in relatively unstructured settings and takes a myriad of shapes and forms. Individuals learn science by Googling to satisfying their curiosity, to answer their need-driven questions, and through hobbies and avocations ranging from scuba diving to gardening, repairing automobiles to bird watching. People learn science while watching popular television (beyond the world of PBS), reading novels, news blogs and magazines as well as when engaged by leisure excursions to National Parks, cruises or day-time outings to zoos, aquariums or children's museums. And people learn science when diagnosed with illnesses or when faced with disasters like floods, contamination or draught. Under these circumstances, learning can be incidental and limited in scope, or alternatively, it can involve enduring engagement with a topic resulting in considerable depth of mastery. For example, research showed that the California Science Center over the course of a decade had positively impacted the science understanding, interest and engagement of roughly two-thirds of the individuals living in greater Los Angeles.— with the greatest impact being amongst the cities lower income and minority citizens (Falk & Needham, 2011). Indeed, research on hobbyists has shown that the conceptual knowledge of amateurs around a topic can exceed that of university science majors (Berendson, 2005; Liu & Falk, in press). Hence, if ISIs were to adopt a single-minded focus on the content and priorities of *NGSS* it would limit the breadth and range of experiences supported every day by the vast ISE infrastructure.

### **Assessment**

*NGSS* emphasizes a particular slice of science learning, namely the big ideas, crosscutting concepts, and practices of science; accordingly these are aspects of science learning that are likely to be assessed. Left out of *NGSS* is a focus on building and developing enduring interest in science. Considerable research shows that interest is a major factor that drives long-term engagement with science (Boe, 2011; Lyons et al., 2012; Ormrod & Duckworth, 1975), including building expectations for careers in science (Tai et al. 2006). While the *NGSS* may offer an improved vision of what it means to teach science, it will be of little value if it fails to improve student attitudes towards and engagement in science. Research suggests that a combination of dispositions, skills, and knowledge termed “science learning activation” positions learners for success in science learning and inquiry (Dorph et al., 2012), yet it is unlikely that these attributes, central to many ISE experiences, will be assessed within the *NGSS* framework. Beyond this misalignment, even if ISIs totally align their efforts with those of the K-12-focused *NGSS*, potential conflicts could arise if assessments are not sensitive to the focus and scale of ISE experiences. Further issues emerge from the fact that what happens at the ISI represents only part of what needs to happen to support *NGSS*. For instance, in the case of school field trips,

what happens in the classroom before and after the trip are critical to making the field trip effective for reaching classroom learning goals (Anderson, Kisiel, & Storcksdieck, 2006).

### **Conclusion**

In conclusion, *NGSS* offers the ISE field an opportunity to rethink existing relationships among formal and informal science education enterprises and leverage the goals embedded within *NGSS* to design informal learning experiences that are simultaneously more aligned-with as well as directly complementary to formal learning goals. As science educators seek to support learners to meet these complex and demanding standards it may require that both the formal and informal sectors need to work to diminish the boundaries between the two in order to support coherent and extended science learning experiences for youth. In particular, the ISE environment may provide many means for students to engage in a wider repertoire of scientific practices than that offered by the formal sector given their constraints on time and facilities. All science educators should work towards a common understanding and shared vision of what good science education is; a vision that includes synergies across sectors and a valuing of all contributions to activating and engaging the science learner. Achieving this vision would be enhanced if ISIs envisioned themselves as part of a larger learning ecology. By seeing themselves in this way, their distinct and original contributions to enhancing the value of STEM result in a whole which is greater than the sum of the parts. Also inherent in this approach is the need for all members of the science education community to learn from each other, to collectively contribute to a vision of science and notions of good professional practice.

Currently there is a lack of emphasis within the *NGSS* for the knowledge, experiences and capabilities that the ISE sector offers. This, in turn, may undervalue what the informal sector can offer and places an onus on the informal community to accommodate, and in some cases sublimate its programs and goals to those of schools. A further concern is that in this age of accountability, ISE providers will be judged by standardized assessments designed to address the specific outcomes and practices of the formal world rather than unique and equally important outcomes and practices they support and develop. While there is much to commend in the *NGSS* and much that ISE providers can contribute, it is important to appreciate that the *NGSS* offer only a partial picture of what constitutes a comprehensive and valued science education.

### **Recommendations**

1. ISIs and schools should collaboratively develop goals for supporting *NGSS* that mutually respect the unique contributions each sector makes to children's science learning.
2. If ISIs are to be assessed within the context of *NGSS*, such assessments should be designed in ways that are sensitive to the actual focus, scale and realities of ISE experiences.
3. ISIs should continue to attend to important aspects of public science education such as interest development and lifelong science engagement; outcomes included within the NRC framework but missing from the *NGSS*.

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