Editorial

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Editorial: Learning science in out-of-school settings

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Editorial on the Research Topic
Learning science in out-of-school settings

Introduction

Science learning outside of school or university extends beyond traditional science content and curriculum and contributes to life-long learning. Most people's learning takes place outside of school (Falk and Dierking, 2010) and can be self-directed or facilitated. Transformative and satisfying experiences can be provided through out-of-school science education (Bell et al., 2009) and life-long learning (Rennie et al., 2019).

This Research Topic collected papers about science learning in diverse programs. The articles share insights about program delivery. They document who benefits from those programs, what benefits accrue and how those benefits are assessed.

The Koru Model (Figure 1) provides a framework for lifelong learning and is used to provide an overview of this Research Topic. The Topic includes 19 articles that involve a range of communication avenues, discuss support for learning in out-of-school settings, and address learners' perceived control and impact of learning opportunities on learners' science identities. Innovative evaluation tools are described that provide evidence of outcomes, including longer term impact in some studies.

Communication avenues

Science learning involves information shared *via* diverse avenues. The root system in the Koru Model is the visualization of a vast and interrelated life-long learning ecosystem whereby facts are curated into information and shared *via* various communication avenues. Diversity of learning venues is reflected in the articles in this Research Topic, with the largest number (nine) being centered in cultural institutions (galleries, libraries, museums, science centers), three in natural places, and single reports related to various spaces (community halls, media, playgroups, etc.).

Different venues provide different benefits. Authenticity of science in real-world venues like workplaces (Berg et al.) can increase learner engagement. Individual learners are likely to prefer different communication avenues. Using alternative venues such as cafés (Nesseth et al.) or libraries (Durall et al.; Peterman et al.) can broaden participation by being inviting to those who aren't necessarily already interested in a specific topic or who don't identify with museums or science centers.

Different types of activity also provide different benefits. Science-art residencies (Lau et al.) brought different disciplines together in a shared space to provide opportunities for creativity and intellectual enquiry. In that study, participating scientists reported new ways of thinking about their research while artists learned new theories and processes which they incorporated into their work. In Lykke et al., the use of imaginary worlds in the form of children's plays served as an intuitive understandable guide to an exhibition's interactive features; the importance of balance and bodily coordination also was clearly mediated through fictional activity.

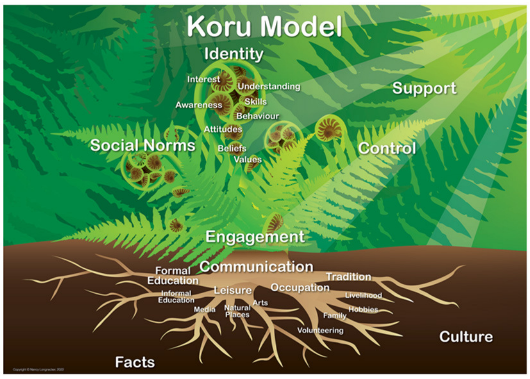

FIGURE 1
The Koru Model of science communication [adapted from Longnecker (2016)]. Individual learners (symbolized by a koru or unfurling fern frond) obtain information from a wide range of communication avenues (roots in this visual metaphor). Learners are more likely to engage with information when it is relevant to them and aligns with their self-perceived identity. Whether and how learners make use of new knowledge is impacted by external factors, including perceived social norms, support, and control. Individual learners use new information to confirm existing schema or to construct new knowledge. The koru is a New Zealand Māori symbol for growth and new beginnings and is used as a sign of respect for mātauranga Māori/ Māori knowledge, culture and values.

Identity

Individual learners may or may not choose to engage with new information and incorporate it into their schema of knowledge. Learners are more likely to engage with new information when it is relevant to their personal needs and interests. Cisneros et al. outline design principles that aligned teen-adult teams based on prior interests and understanding, thereby increasing relevance and likelihood of engagement. Seebacher et al. examine the complexity of learning ecologies and stress the need to adapt to diverse needs and preferences to improve equity of access. Durall et al. address diversity in their *Design for Everyone* principle. Their recommendations include being culturally responsive, showing diversity amongst people engaging in science, fostering diversity in participants, and being sensitive to diverse needs of participants.

Identity is complex, comprising one's values, beliefs, attitudes, awareness, interests, understanding, skills and behavior. As learning is continuous and individual learners construct their knowledge, Falk and Meier recommend that informal educators expand their efforts beyond the temporal and physical boundaries of their programs. Design principles can be used to inspire and motivate (Durall et al.) and to give participants a voice (Howitt and Rennie). The photobook tool used by Howitt and Rennie enabled children as young as three to develop their science identity.

The importance of parents' perceptions of their children as young scientists and attitudes about science was noted in the studies by Howitt and Rennie and Falk and Meier. Cisneros et al. described a multigenerational community conservation program that provides a platform for teens and adults to view themselves as capable contributors to meaningful STEM endeavors. Increased self-concept in science and intention for future participation in science resulted after an intensive week-long experience where young volunteer presenters helped others with interactive exhibits and explained science concepts at a traveling science center (Sripaoraya et al.).

Support

Support is an external factor that influences learners' engagement with and use of information. Support for self-authoring of STEM identities is noted in various articles (e.g., Cisneros et al.; Durall et al.). Massarani et al. described conversations among family groups whose motivations for visiting a museum included leisure, enjoyment and teaching something to a child in the group. In that study, discussions involved caregivers providing explanations to children about specific science concepts like how tides are formed or how the moon moves. Support offered within groups of visitors to the physically interactive exhibition studied by Lykke et al. was more likely to focus on *how* to complete the activities.

Corral et al. demonstrated that facilitators at a science center enabled visitors to use exhibits properly and to engage in advanced learning behaviors. Similarly, the facilitation of rangers who led walks in a national park was impactful for visitors (Forist et al.). Peterman et al. describe a virtual coaching program for out-of-school-time educators, using design-based implementation research to scale up informal education programs in diverse settings.

Control

Design for increased control by learners can impact their use of information. Interactivity is one design feature that provides opportunity for participants to have some control of their experience. For example, Lykke et al. describe interactive features of a whole-body exhibition that enable visitors to interact and transform their experience and new information into new knowledge. They found that group work and planning were engaging features in a whole-body museum exhibition that were important, enhanced interaction and were enjoyed. The features were demanding enough to reduce time for in-depth exploration of the science themes presented. Using learning flow diagrams to illustrate changes in pre- and post-visit responses to physics content questions, Solis et al. demonstrated that visitors who interacted with exhibits were more likely to change to a correct answer, in comparison to non-interacting visitors.

Science Cafés (Nesseth et al.) are designed to be relatively informal and to provide for dialogue between potential learners and experts, giving participants more control over the interaction. Two-way dialogue between experts and users of their knowledge is often a preferable form of science communication when compared to didactic, one-way communication (e.g., Manyweathers et al., 2020).

Another design feature that can enhance participant control is hands-on work with an authentic activity; this may enable participants to develop a sense of ownership of their personal contribution. For example, motivation is enhanced when participants are active contributors to scientific knowledge (Carson et al.) or conservation actions (Cisneros et al.). Berg et al. recommend incorporation of problem-based learning to stimulate learner-centered approaches.

Evaluation tools

Some of the methods reported in this Research Topic involve creative approaches to evaluation of program outcomes. Richard et al. combined concept maps and use of an emoji scale with other data collection methods. Innovative methods included photobooks (Howitt and Rennie), walking interviews (Lykke et al.), and point-of-view camera recording of family museum visits (Massarani et al.). The Zines described by Brown et al. are a flexible tool for reflective evaluation which can be particularly useful with marginalized learners and across cultural contexts.

The report by Staus et al. encourages further work to address the challenge of the ceiling effect which makes it difficult to measure impact of a program when participants already have highly positive attitudes or advanced knowledge.

Outcomes

It is useful to document factual learning outcomes of informal education opportunities. This can be difficult, especially in venues or programs that provide optional activities, because of the large impact of individual motivations that lead to unique experiences for different visitors. Nonetheless, even after a single outing to a science center with many exhibits, Solis et al. were able to document that visitors gave more correct answers on a quiz about the physics content that was illustrated in the center, independent of age and gender. Carson et al. also note increased learning of science content after participation in a citizen science program where participants contributed to new knowledge related to a local issue—the environmental impact of dredging in a harbor.

Other positive outcomes documented in this Research Topic include enhanced science identity as described above, increases in positive attitudes about science and self-efficacy (Sripaoraya et al.), positive emotions about science (Richard et al.), positive environmental attitudes (Carson et al.), and development of skills (e.g., Berg et al.).

Learning science outside of school settings may enhance critical thinking, social learning and other twenty-first century skills. As learning is cumulative, it may not be surprising that few students reported increase in something as complex as critical thinking after a short-term program assessed by Richard et al. In contrast, Falk and Meier found increased creativity, STEM interest, and problem-solving skills after a 1-week long, day-camp experience for 10–12 year olds; *out-of-school pre-camp experiences* was the factor that explained the greatest proportion of variance in those participants' outcomes.

Longer-term impacts of participation in learning opportunities is a challenging but important aspect to measure. Positive longer-term impacts were noted in reports by Carson et al.; Cisneros et al.; Falk and Meier; Forist et al.; Howitt and Rennie; Sripaoraya et al. For example, Forist et al. note that months after a ranger-led hike in Indiana Dunes National Park, visitors could give examples of dune formation and change, human effects on landscape and findings from a scientific study that had been described.

Conclusions, limitations, and future work

This Research Topic provides insights about design of programs, tools for assessing impact and examples of positive outcomes. Nonetheless, it addresses science learning in privileged situations with a plethora of opportunities for learning. Many of the authors in this Research Topic recognize that even in situations described here, with diverse opportunities for science learning, those opportunities are not necessarily equitably accessed by people from diverse backgrounds and abilities. Some authors have recommended design options to improve equity. Future opportunities for science learning with different audiences could explore diverse communication avenues such as gaming and traditional knowledge. In this Research Topic, program and exhibit characteristics which enable different visitor experiences and learning have been elaborated, providing foundations for further work.

Author contributions

NL drafted the manuscript. All authors contributed, edited, and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Bell, P., Lewenstein, B., Shouse, A. W., and Feder, M. A. (2009). *Learning Science in Informal Environments: People, Places and Pursuits.* Washington, DC: National Academies Press.

Falk, J. H., and Dierking, L. D. (2010). The 95 percent solution. *Am. Scientist* 98, 486–493. doi: 10.1511/2010.87.486

Longnecker, N. (2016). An integrated model of science communication – more than providing evidence. *J. Sci. Commun.* 15, 1–13. doi: 10.22323/2.15050401

Manyweathers, J., Taylor, M., and Longnecker, N. (2020). Expertise and communicating about infectious disease: a case study of uncertainty and rejection of local knowledge in discourse of experts and decision makers. *J. Sci. Commun.* 19, A01–10. doi: 10.22323/2.19040201

Rennie, L., Stocklmayer, S., and Gilbert, J. (2019). *Supporting Self-Directed Learning in Science and Technology Beyond the School Years.* London: Routledge.