PATHWAYS IN ENVIRONMENTAL LITERACY

ENVIRONMENTAL LITERACY BRIEF VOLUME 2

The pathways framework takes a macro view of components that comprise a person's unique, lifelong learning trajectory. Environmental education (EE) programs and experiences may be one component of such a pathway, as they can influence how, what, where, when, and with whom people learn about the environment. Those experiences occur within people's broader lives.

Learning Pathways

Environmental learning is complex: it occurs throughout an individual's lifetime, across diverse settings and experiences (such as school, work, home, and hobbies), and includes different facets from conceptual understanding and problem solving to shifting identity. Given this complexity, environmental literacy can be imagined as a learning trajectory, or pathway, that integrates the dynamic interplay between the individual and the context. In this brief, we elaborate on the pathways approach to learning, drawing from three related frameworks:
(1) Interest development pathways,
(2) Cultural learning pathways, and
(3) Equity pathways.

These pathway approaches draw on similar theoretical ideas and fields of study. They are rooted primarily in sociocultural (e.g., Greeno, Collins, and Resnick 1996; Rogoff 2003; Vygotsky 1978) and ecological (e.g., Brofenbrenner 1977) theories of development. In addition, the pathways' lenses derive from the science education and informal learning literatures, highlighting various aspects of life-wide, life-long, and life-deep learning (e.g., Banks et al. 2007; National Research Council 2009).

Science education scholars have discussed and researched scientific literacy for many years, not only related to its constituent elements, but also with regard to its value and how people use science, both personally and as a shared endeavor (National Academies of Sciences, Engineering, and Medicine 2016). As a field, science education has made strides in articulating the complexity of scientific literacy and, therefore, may offer guidance for understanding environmental literacy, as well. Although the pathways we discuss build on similar theoretical foundations, they each present a different focus.

Interest Development Pathways

Theories about interest development provide important insights on how to support ongoing curiosity, awareness, and interest in the environment, which are key aspects of environmental literacy. We present three frameworks that highlight the social context in examining an individual's interest development: learning ecologies, lines of practice, and community-connected resources and networks.

Learning ecologies. The ecological model of human development is a child-centered framework that emphasizes the influence of physical and social experiences on a child's development. (Brofenbrenner 1977). The immediate context influences the child, who is in the center of the model. That context consists of people with whom the child interacts (for example, family, peers, and teachers), the settings in which the child lives and grows (such as home, school, and community places), and the broader social context and institutions that exist in society.

Some researchers extend this model of child development through concepts such as *learning ecologies* (e.g., Barron 2004, 2006), which refers to all learning-rich spaces including, but not limited to, schools, homes, cafes, parks, zoos, aquariums, museums, nature centers, libraries, after-school programs, hobby clubs, and virtual settings. Importantly, a learning ecology framework emphasizes the role of social and cultural activity and it, therefore, includes relationships and interactions with people, as well as identity development (Greeno 1989; Lave and Wenger 1991; Rogoff 2003; Vygotsky 1978). Participating in apprenticeships with parents or mentors, playing games with peers, or teaching something all foster interest, identity development, and a sense of belonging while moving learners toward greater expertise (Barron 2006). As learners develop independence and assert themselves, they shape their own learning ecologies and trajectories (Barron 2006).

Barron (2006) provides examples of the learning-ecology process. She conducted case-study research of children's learning ecologies, resulting in a number of people-in-context descriptive portraits. For example, Stephanie,[1] a middle-school student, developed an interest in computers and web design based on her interactions with peers, access to online resources, and participation in classes in school. Her curiosity originated informally when she participated, along with her friends, in an online community called Geocities. As part of this community, she created websites and blogs. Stephanie linked this activity to one of her prior interests, namely art, and she viewed her creation of images using software tools in alignment with this interest in art. Her informal participation in this activity led to her enrolling in a technology class in school where she was able to sustain her interest. The study highlighted that Stephanie's interest and learning were situated in her relationships and interactions with people. She had a friend who was her "constant learning partner," as well as a broader network of peers who were interested in computers. Such peer relationships continually reinforced her interest in computers (Barron 2006).

[1] Names are pseudonyms.

Lines of practice. Drawing on sociocultural theories (Lave and Wenger 1991; Rogoff 2003), Azevedo (2011) examines long-term interest development by studying hobbies, particularly model rocketry. Similar to Barron (2006), Azevedo (2011) argues that ongoing engagement in a hobby must be understood within one's social and cultural contexts. His *lines of practice* theory refers to the various ways in which an individual engages with a hobby based on the individual's preferences, as well as the supports or impediments to participation. One line of practice for David, a model rocketeer in the study, was "cheap and wacky rockets," born out of David's preference for unusual rocketry design while working with a restrictive budget.

Azevedo (2011) also argues that, for an interest to persist, it needs to provide value to one's life beyond the particular topic. In the case of the model rocketeer study, for example, one value for a rocketeer was building and sustaining social relationships. As model rocketeers often came together as a group to engage in their hobby, the hobby provided social benefits in addition to the enjoyment of constructing and flying rockets. The lines of practice lens offers a way to understand continual engagement by examining not only one's interest in a specific topic, but also the social and structural intricacies of engaging.

Community-connected resources and networks. Recognizing that young people leverage a variety of community resources and networks to develop interests both in and out of school, Oregon State University researchers are engaged in a four-year study called SYNERGIES, which explores science, technology, engineering, and mathematics (STEM)-related youth interest pathways (Falk et al. 2016; Synergies in the Parkrose Community n.d). The researchers consider the ways in which pathways across settings and over time create synergy among school, home, after-school, and other community-based educational opportunities available to youth. In one study element, the researchers examine when, where, how, and why STEM interest pathways develop (or diminish) among a group of adolescent youth (10–14 year olds) from an ethnically diverse, under-resourced neighborhood in East Portland, Oregon (Falk et al. 2016). The study builds on theoretical conceptualizations of interest and learning ecologies (Barron 2004, 2006; Hidi and Renninger 2006, Krapp 2007).

The researchers claim that their approach to examining STEM dimensions simultaneously is necessary, given that prior research in interest or attitudes often focuses on science, technology, engineering, and mathematics topics in isolation. The SYNERGIES study considers the bigger picture: how does youth interest in four STEM dimensions (earth/space science, life science, technology/engineering, and mathematics) change over time, and how do personal, social, and environmental factors impact those interests?

Initial findings indicate that students' STEM interest increased significantly between fifth and sixth grade. Researchers surmised, however, that this could be due to an overall increase in exposure to STEM-related experiences and topics during middle school. The research indicated a slight gender difference, with sixth-grade boys being somewhat more interested in technology and engineering than girls, although no gender differences existed for the other STEM dimensions. By eighth grade, however, students' interest in earth/space science and technology/engineering had significantly decreased.[2] In addition, the students' participation in out-of-school STEM-related activities, such as gardening, watching STEM-themed television programs, and going to the local science museum, significantly decreased. Given that prior research has emphasized the importance of participation in such activities for sustained interest development, the finding that STEM participation decreased is concerning (Falk et al. 2016).

With regard to which factors corresponded with STEM interest, students with greater interest in STEM also reported higher STEM knowledge, science values, science enjoyment, parental attitudes toward science, and career aspirations as a scientist. Building on theoretical ideas in interest development, the researchers emphasized that these interest-related factors (such as science enjoyment, parental attitudes toward science, and science relevance) are key elements in the processes related to interests becoming long-lasting (Hidi and Renninger 2006).

[2]Gender differences were not reported for eighth grade. Researchers noted that eighth graders were not part of the initial target cohort, although some pilot data had been collected.

Cultural Learning Pathways

Cultural learning pathways offer another perspective on developing environmental literacy and emphasize a holistic view of how people learn over the course of a lifetime as well as across diverse settings embedded in social and cultural values (Bell et al. 2012). Researchers describe these pathways as "connected chains of personally consequential activity and sense-making" (Bell, Tzou, and Baines 2012, 270). Grounded in sociocultural and situated learning theories (e.g., Lave and Wenger 1991), as well as psychological theories about people's participation in varied social contexts (Dreier 2009), Bell and his colleagues employ ethnographic research approaches to explore how power structures, privilege, and marginalization influence science learning pathways within and across learning environments. An individual's cultural learning pathway may start through an interest or concern (either personal

or one shared by community members), such as protecting one's community from environmental hazards (Bell et al. 2012). As learners pursue such initial interests, they start participating in social activities, build meaningful relationships, and develop specific activity-linked identities through ongoing participation (Bell et al. 2012).

To highlight what cultural learning pathways look like, Bell and his colleagues provide ethnographic accounts of elementary-aged children from non-dominant backgrounds[3] who engage in science and technology learning across multiple social settings. The researchers use the cultural learning pathways framework as a lens to explore how different contexts and events in one's life might connect over time, as well as how those contexts and events might work toward forming interest, building identity, and participating in a practice.

The researchers present an ethnographic account of Sam, a fourth grader who developed an interest in design and building. Certain contexts, namely his home and a local science center, supported this interest development, while others, such as school, did not. In his home context, Sam's parents were supportive and encouraging of his developing sophisticated engineering interest. Sam internalized this identity, which further developed his strong interest in building and engineering. Despite having limited means and resources, Sam's parents expended significant financial resources toward developing his interests. They bought him toys that focused on creative construction/building, which encouraged Sam to pursue his hobby. Sam also deepened and augmented his interest by visiting a science center, where he engaged physically with exhibits for long periods.

The school environment, on the other hand, did not appear supportive of Sam's interests. The teachers viewed him as "off-task and resistant to instruction" (Bell et al. 2012, 278). The researchers saw Sam's problematic academic identity as his way of resisting against the power structures and practices of school, "which did not support his interests and stripped him of opportunities to showcase his developing engineering-like practices" (Bell et al. 2012, 278). This example highlights an important aspect of cultural learning pathways, namely that a person's interests may not always be supported, recognized, or aligned with the learning agenda in traditional educational settings, such as schools.

Related studies have examined how different cultural learning pathways may misalign in environmental education. In a study of an outdoor residential EE program, for example, researchers found that some of the students' everyday-life experiences contrasted sharply with the practices of the residential EE community, such as unlocked bedrooms and night hikes supported by the camp (Tzou, Scalone, and Bell 2010). These students expressed fear of "being taken" from their beds or while walking outdoors in the dark, based on their lived social reality (Tzou, Scalone, and Bell 2010, 111). The researchers also highlighted how behavior-change messaging from program educators and staff might be incongruent with what participants would or could actually do in their lives. In this case, the program director gave students a "tip for the earth," where he said that the earth would be a much better place if we all walked, rather than drove, as our primary form of transportation (Tzou, Scalone, and Bell 2010, 211). This particular pro-environmental behavior narrative, makes assumptions about setting, agency, and cultural norms, including, but not limited to, aspects such as safety of walking corridors, level of comfort with and enjoyment of walking, and so on.

Equity Pathways

Relatedly, learning pathways have also been conceptualized as *equity pathways*. In this approach, science education researchers focus on the connected people and places in which learning occurs, rather than on specific outcomes (Equity Pathways in Informal STEM Learning n.d.).[4] As problematized and described by researchers involved in an equity pathways initiative, learning and achievement in STEM programs historically have been characterized by a "pipeline" metaphor. This pipeline essentially envisions a single path for all students, from middle school to

[3] The researchers define "non-dominant backgrounds" as having learning disabilities or coming from a first-generation immigrant family, for example.

[4] The equity-pathways references come predominantly from a series of briefs (Dawson et al 2015a, 2015b) developed for a Science Learning+ grant, which is a partnership between NSF and the Wellcome Trust with the UK Economic and Social Research Council (ESRC).

high school to college, which results in a STEM-related degree or career. More recently, however, researchers have shown that there is no single regimented path into STEM; instead, multiple trajectories exist (Cannady, Greenwald, and Harris 2014). "Various lane switches" and "on/off ramps" characterize those trajectories (Dawson et al., 2015a, 3).

The pathways approach to describing STEM learning trajectories is becoming more common as, rather than a single, predetermined path that describes how *all* students navigate STEM fields, this approach celebrates each person's unique learning trajectory. The trajectory is comprised of multiple experiences built over the course of a lifetime and situated within diverse contexts (e.g., Barron 2006; Dawson et al. 2015a, 2015b). Within each individual pathway, a learner navigates through different types of learning spaces (such as schools, homes, museums, and after-school programs) and leverages a variety of available resources (such as teacher-mediated learning, peer and family interactions, books, and web resources) to engage with STEM and progress toward possible futures in STEM-related areas.

Within this perspective, theories about equity are rooted in work that explores how youth use science for their own interests and understanding (Calabrese Barton et al. 2003). Researchers argue for thinking beyond traditional notions of science education to include students' concerns, everyday experiences, and scientific mindsets (Calabrese Barton et al. 2003). This perspective highlights the value of participants' understanding and use of science, even if their perspectives do not align with those of the mainstream and/or a "prescribed way" of learning science in a school or program. The equity pathways initiative emphasizes that, while pathways highlight a forward-looking trajectory of how people may be involved in science, future directions for any individual vary based on their interests in and uses of science. Moreover, contextual conditions provide opportunities or can create barriers.

Initial analyses from the equity pathways initiative revealed four central notions of pathways: elements, movement, successful outcomes, and challenges. *Elements* of pathways include places, such as schools, museums, and community spaces, as well as people, such as friends and family. *Movement* refers to how individual learners' unique goals and choices shape pathways. "Obstacles and stepping stones" (Dawson et al. 2015a, 3) can make moving through the pathway more or less difficult, while movement in the pathway can be impacted by a critical event such as a fieldtrip or a mentor. *Successful outcomes*, defined broadly, include: (i) access and opportunity (i.e., to engage in informal science learning experiences in meaningful and culturally relevant ways); (ii) agency and choice (learners are able to shape their pathways based on their unique contexts, needs, and individual interests); and (iii) valuing/legitimizing youth experience (programs should value learners' cultural knowledge and experiences). *Challenges* include cost, such as program-development funding and financially sustaining programs; differential quality of instruction/facilitation across informal learning settings; lack of professional development opportunities; and societal norms that privilege one pathway type while marginalizing others. These initial analyses emerged from multiple discussions about pathways from researchers and informal learning science practitioners and from maps that the researchers created to visualize youth's science learning pathways (see Dawson et al. 2015a, for example).

BOTTOM LINE FOR PRACTICE

A unifying theme across these pathway lenses is that learning develops in multiple settings over time, based primarily in a learner's interests and what supports or constrains those interests. To motivate learning through a pathways approach, educators, programs, and institutions ought to, in so much as they can, focus on what is important to learners rather than a specific outcome as determined by the school or program. Although pathways described in this brief are in the context of informal science and STEM learning, this concept extends to other domains that also include science, such as *environmental literacy*.

For any individual, environmental literacy can be considered a lifelong, dynamic endeavor shaped by sociocultural contexts. Environmental literacy develops in a variety of settings, influenced by relationships with people and places, access to resources, and meaningful activity. Although every person has her/his own unique trajectory toward environmental literacy, that trajectory has no endpoint as environmental issues and contexts continuously change and learning is a lifelong endeavor. Therefore, the environmental literacy pathway is continuous.

So, what are the implications of the pathways framework for environmental education?

First, environmental education programs are not stand-alone learning experiences. Rather, they exist within broader learning contexts, or pathways. EE programs may be critical points in a journey, and they can be powerful, transformative experiences that lead to new interests, ways of knowing, and forms of participation. By the same token, the EE experiences may or may not be transformative experiences in and of themselves.

Second, given their unique nature, pathways require flexible design, rather than regimentation, with components (such as EE programs) that maximize access to meaningful, engaging learning opportunities. To achieve that, programs must recognize participants' prior interests and experiences; in the process, programs connect with them in culturally relevant ways. In addition, programs that foster agency, authenticity, and a sense of belonging can be more meaningful for participants. Furthermore, program staff and educators need to be attuned to the way in which their communication and program rituals may be consistent and inconsistent with participants' lives. Programming that respects and responds to the lived experiences of participants, especially those from non-dominant and minority communities, might help move toward inclusiveness.

Third, relationships with peers and adults form key components of young people's learning pathways because they may represent starting, stopping, or reflective points of deep, sustained engagement (Dawson et al. 2015a). It follows that high-quality programs will provide participants with a supportive learning environment in which educators make efforts to recognize participants' needs, struggles, and interests, which is more likely to occur when educators also recognize their own biases and assumptions. A safe and supportive learning environment provides space for participants to discuss, explore, and express their attitudes, ideas, and emotions, for example, rather than directing them toward particular outcomes or behaviors. Within the pathway, the supportive learning environment is embedded in the participant's larger life context.

Fourth, given that pathways include different learning environments (such as home, school, parks, and museums, among others), harnessing community resources, collaborations, and partnerships may provide a synergistic avenue to integrating family, school, and community efforts.

Finally, high-quality research and evaluation can assist in characterizing the ways in which EE programming can support pathways to environmental literacy. For this, it is essential that evaluation occurs not just at the program level, but also at the community level. (The National Research Council [2015] discusses this further.) Community-level evaluation efforts focus holistically on the learning ecosystem, or the "big picture," meaning they consider the diversity of learning places and opportunities available to learners, explore how a particular program fits within the larger framework, and assess whether—and in what ways—programs support and expand on opportunities available within communities and across settings.

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