LEARNING, DEVELOPMENTAL, AND ENVIRONMENTAL ACTION PROGRESSIONS

ENVIRONMENTAL LITERACY BRIEF VOLUME 3

In the process of supporting the development of environmental literacy in youth and adults, environmental education (EE) programs may choose a sequence of focus or emphasis. This may occur as a threading across multiple programs and/or within the program itself. Experiences in one part of a sequence lay the foundation for continued learning and development in the next part of the sequence.

In this brief, we unpack the ways that research and practice define a sequence of focus, or a progression. We also explore bodies of literature that speak to the formation of those progressions, particularly with regard to learning progressions for conceptual understanding and developmental progressions in human–nature connections.

In our review of progressions, we categorize the literature into three broad themes based on the scale of how researchers conceptualize the term "progressions":

1. Learning progressions: Core disciplinary ideas in science and environmental science education;
2. Developmental progressions: Human–nature relationships and environmental mindsets;
3. Environmental action progressions: Relationship of awareness, attitudes, and knowledge.

Learning Progressions in Science and Environmental Science Education

Science education. In its 2007 document *Taking Science to School*, the National Research Council defines learning progressions as "successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate the topic over a broad span of time" (2007, p. 214). In other words, learning progressions are successive, sequential steps that occur in a learner's thinking, as one moves from simple to complex (advanced) understandings about a topic.

Situated in a constructivist view of learning, learning progressions are research-based accounts of how people develop an understanding of specific topics or ideas in a sequential manner. In science education, the body of work related to learning progressions emphasizes building scientific literacy through connections threaded among core principles and practices (Alonzo and Gotwals 2012; Corcoran, Mosher, and Rogat 2009; Duschl, Schweingruber, and Shouse 2007; Songer, Kelcey, and Gotwals 2009). However, unlike more traditional approaches to science education, in which the path to disciplinary instruction and learning is guided primarily in a top-down manner, privileging the learning system's and educator's perspective, a learning progression perspective also grows in a bottom-up manner, incorporating research based on students' ideas of science (Alonzo and Gotwals 2012). Moreover, researchers claim that this bottom-up perspective is a first for science education: the study of learning progressions provides opportunities for students' ideas to be considered core to the development of a science-learning framework (Alonzo and Gotwals 2012).

Significant variation occurs in how researchers define, conceptualize, and operationalize learning progressions, as what comprises a progression differs by researcher and project (Alonzo and Gotwals 2012). Learning progressions in science vary by topic and timespan. Progressions are typically organized by core disciplinary ideas or topics in science, such as *atomic-molecular theory of matter*. Consequently, what is defined as a progression is specific to the topic or idea under consideration. Moreover, learning progressions have been defined for varying time spans, ranging from a few weeks to multiple years. For example, some researchers defined an eight-week learning progression for the particle model of matter (Merritt, Krajcik, and Shwartz 2008), while others defined a multi-year learning progression for children's learning of Atomic Molecular Theory (Smith et al. 2004).

Many science-education scholars argue that learning progression research provides much-needed perspectives on how to support students through deep, disciplinary thinking about fundamental science principles. In addition, although the Framework for K–12 Science Education (National Research Council 2012) does not directly include learning progressions, some of the learning progressions research informs the document's design and development (Alonzo and Gotwals 2012).

Critics, however, have voiced concern that researchers, practitioners, and policymakers have embraced and implemented learning progression approaches before developing a solid research basis in this area (Shavelson and Kurpius 2012; Krajcik 2012). In response to, and in recognition of, the hypothetical character of learning progressions, some have pursued more grounded learning-progression work, with the intention of further developing related understandings for potential use. Such applied approaches have focused on areas including, but not limited to, curriculum development (Wiser, Smith, and Doubler 2012), teacher professional development (Furtak 2012), and the design of related testing and standards (Foster and Wiser 2012).

Environmental science education. Researchers and practitioners have applied learning progression research in the realm of environmental science

through progressions around principles such as the carbon cycle, diversity and evolution in environmental sciences, climate change, and reasoning around ecological issues (Anderson et al. 2006; Hestness et al. 2014; Jin, Johnson, and Yestness 2015; Hokayem and Gotwals 2016). This approach relates to environmental literacy by providing a framework for the development of conceptual understanding and critical-thinking skills in environmental science.

Much of the learning progression work in environmental science education comes from an NSF-funded initiative on *Culturally relevant ecology, learning progressions, and environmental literacy* (Pathways Project 2013). In this initiative, the researchers collaborated with 22 K–12 schools across the United States to develop learning progression frameworks and associated professional development materials and assessments. Researchers divided the project into four strands, three of which (biodiversity, carbon cycling, and global water) centered on environmental science domains. Research groups developed and validated learning progressions that described how elementary through high school students develop an understanding of these complex topics (Gunckel et al. 2012a; Jin and Anderson 2012a, 2012b). The fourth strand focused on environmentally literate citizenship through which researchers developed learning progressions demonstrating how students' understanding of environmental science and scientific practices help them make socio-ecological decisions. Specifically, the researchers identified three key practices fundamental to using science as a tool for citizenship: investigating issues, explaining and predicting, and deciding on courses of action (Covitt, Harris, and Anderson 2013; Gunckel et al. 2012b; Pathways Project 2013).

Researchers also discussed challenges inherent to, and implications of, learning progressions in curriculum, assessment, and instruction. Gunckel and colleagues (2012b) described two challenges to developing learning progressions for environmental literacy. The first challenge lies in *defining what progresses in a learning progression*. To do this analytically, the researchers examined participants'

discourse and language. Drawing on sociocultural theory, the researchers considered "discourses" as meaningful ways of "talking, thinking, and acting" within a community of practice. For example, the practice of science can be seen as a type of discourse practice in which scientists have well-defined ways of talking, thinking, and acting. According to the discourse lens, children talk and reason about a specific topic (such as the water cycle) in ways that are different from how scientists think and reason about a topic. Learning science, then, means moving from a primary informal, everyday language toward mastering the secondary discourse of science, such as language and practices of scientists. Thus, in an environmental literacy progression, at one end of the progression students use everyday language and thinking; at the other end, students employ scientific reasoning and discourse in their role as democratic, environmentally literate citizens (Gunckel et al. 2012b).
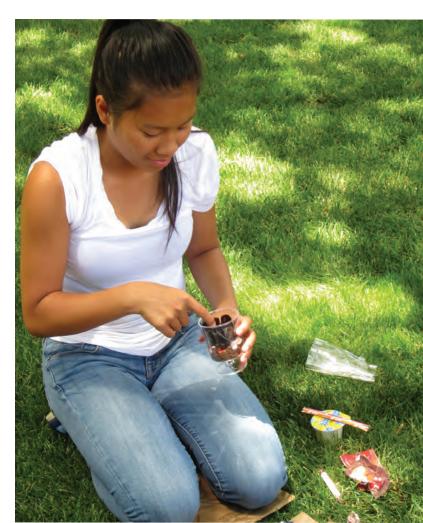
Gunckel and colleagues (2012b) presented a second challenge: *describing the role of instruction in defining learning progressions.* In addressing this challenge, the researchers identified pathways that students take and how those may link to instructional approaches. Specifically, they highlighted pathways that students take while moving from their primary discourse to a secondary discourse in a carbon-cycle learning progression. In doing so, the authors emphasized that learning the basic principles (such as the hierarchy of systems at different scales and the conservation of matter and energy) plays a central role in scientific reasoning. The authors suggested a "principles-first" instructional approach toward environmental science literacy (Gunckel et al. 2012b).

Other research has described an empirically driven development of a three-year learning progression. This approach focuses on complex biodiversity-related reasoning in the context of curriculum and assessment development. With regard to curriculum development, the progressions act as templates for developing organized sequences of curricular units. For assessment development, researchers suggest that learning progression-guided assessments might be

more reliable than more standardized measures for distinguishing between students of differing abilities in their understanding of biodiversity (Songer, Kelcey, and Gotwals 2009).

Developmental Progressions in Human–Nature Relationships and Environmental Mindsets

Another body of work using progressions focuses on developing an environmental mindset through specific life stages, which may connect with environmental education programming. Writers and researchers in this vein draw on developmental psychology to conjecture about age- and stage-related relationships with nature. For example, exposure to environmental challenges, such as deforestation and climate change, can be more appropriate in middle than early childhood, as early exposure may produce anxiety and fear (Sobel 1996). Sobel outlines three stages of environmental education curricula from early childhood to early adolescence— early childhood (4–7 years of age) EE ought to foster

empathy toward the natural world, middle childhood (8–11 years of age) EE ought to involve exploration in nature, and early adolescence (12–15 years of age) EE ought to focus on social action. In this argument, adults are responsible for considering young people's developmental and emotional trajectory and, as such, supporting children's empathy and exploration before encouraging them to undertake social action.

One researcher has found these three stages to correspond with empirical analyses. In an examination of a place-based educational program focused on prairie restoration, certain environmental literacy components that teachers foster, such as positive emotions toward the natural world and a belief in being able to create change for a healthy natural world, corresponded with the development of place-based relationships between children and nature (Shume 2016). Thus, Sobel's phases potentially can be a framework to support curriculum development for place-based approaches in EE programming.

Researchers have proposed a model of environmental identity development focused on children's cognitive relationship with nature that spans birth to adulthood (Green, Kalvaitis, and Worster 2016). Based on work of psychosocial stages (Erikson 1972), the model includes suggestions for environmental education in supporting developing stages, such as trust in nature, spatial autonomy, environmental competencies, and environmental action. Similarly, other researchers have proposed environmental developmental stages based on age. In one study, researchers found that fourth grade children (9–10 years of age) had higher connectedness-to-nature scores as measured by the Inclusion in Nature Scale than sixth grade children (11–13 years of age) (Liefländer et al. 2013). They also found that participating in environmental education resulted in short-term gains in connectedness with nature for children of *both* age groups, but the connectedness was sustained over the longer term only among the younger kids (Liefländer et al. 2013). Similarly, in a retrospective analysis of adults, those who were exposed to "wild nature" before age 11 were more likely to exhibit pro-environmental behaviors and dispositions (Wells and Lekies 2006).

Younger years are not the only important time for nature connection. Different types of outdoor experiences are important at different stages of a person's life. In early childhood, free play and exploration are critical to developing an interest in the natural world. In later childhood and early adolescence, formal activities such as summer camps, clubs, scouting, and science classes can be particularly influential in fostering environmentally related interests. In early adulthood, relationships with coworkers and mentors (such as university professors) can be particularly influential related to environmentally related career choice (Chawla 2009).

In addition, "mastery experiences," which occur when children attempt to do something that they consider significant and then experience success, are important for building children's sense of self-efficacy (Chawla 2009). Programs for middle- and high-school-aged students exemplify the importance of mastery experiences, and include critical elements of actively involving participants over longer periods of time (Zelezny 1999). For instance, students in those programs might learn about environmental problems in their home communities, devise action plans, and then become engaged in applying their skills to address those problems.

Other researchers have employed retrospective interviews to explore the prominence of social relationships and participation in outdoor-related activities in various life-stages of development in natural history professionals (James, Bixler, and Vadala 2010). Similar to the aforementioned research, James and colleagues found that unstructured exploration, fantasy play, and family members dominate early childhood experiences. On the other hand, during the adolescent years, family influence decreases and the roles of other knowledgeable adults, such as teachers and environmental professionals, become more prominent; those people become mentors who recognize adolescents' interests and encourage them to participate in environmental activities and professions.

Environmental Action Progressions: Relationship of Awareness, Attitudes, and Knowledge

The idea that a progression toward pro-environmental action[1] exists is historically common among researchers and practitioners. Researchers, as well as anchoring documents in the environmental education field such as the Tbilisi Declaration,[2] have generally supported the notion that environmental literacy develops in stages from awareness to action. Although individual variation exists, researchers and practitioners commonly characterize those stages as: (1) awareness, (2) concern, (3) understanding, and (4) action (Roth 1992). Similarly, other researchers have envisioned "levels of learning" as an environmental-literacy framework, arguing that "environmental literacy is the outcome of a sound program of environmental education through which the learner progresses from deep knowledge, to skill, to actual field application" (Coyle 2005, 54). Such a framework describes the three levels of learning as: environmental awareness, suggesting familiarity with environmental issues; personal conduct knowledge, using individual awareness to take personal action; and true environmental literacy, understanding environmental issues and principles as well as the skills needed to apply knowledge and investigate issues (Coyle 2005).

Many researchers and practitioners have supported this awareness-to-knowledge-to-action progression, yet others question whether the process proceeds in a causal or hierarchical manner (Athman and Monroe 2001; Hungerford and Volk 1990; Kollmuss and Agyeman 2002). Relatedly, empirical research repeatedly demonstrates that knowledge and attitudes do not lead directly to increased pro-environmental action, particularly when that action

needs to be maintained over time or when the knowledge or attitudes lack connection to a specific behavior (Heimlich and Ardoin 2008; Kollmuss and Agyeman 2002).

A number of variables and contextual considerations influence the attitude–behavior connection. One key aspect relates to an individual's efficacy-related attitudes, or how efficacious an individual feels in performing the behavior (Heimlich and Ardoin 2008). Another relates to the specificity of the attitude toward a particular problem: the more closely tied an attitude is to an issue, the more likely an individual is to engage in related environmental action (Heimlich and Ardoin 2008). Similarly, with regard to environmental knowledge, some researchers argue that the amount of knowledge does not determine behavior but, rather, that different forms of knowledge converging toward a specific environmental goal are more important (Kaiser and Fuhrer 2003). Researchers theorize that different forms of knowledge, namely *declarative knowledge* (about environmental systems); *procedural knowledge* (about how to take a particular action); *effectiveness knowledge* (about cost versus benefit of engaging in particular behaviors); and *social knowledge* (knowledge of social norms, beliefs, and context) can be influential when presented together (Kaiser and Fuhrer 2003).

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[1] The research on environmental behavior is expansive, drawing from multiple disciplines and fields, and building over decades; thus, it is too expansive to review comprehensively in this brief. Given that much EE practice focuses on a behavioral or action outcome, we discuss some general trends of how EE practice has been conceptualized along a progression.

[2] In October 1977, the world's first intergovernmental panel on environmental education convened in Tbilisi, Georgia (USSR). The United Nations Education, Scientific, and Cultural Organization (UNESCO) and the U.N. Environment Program (UNEP) jointly organized the Tbilisi conference, which produced a document that "constitutes the framework, principles, and guidelines for environmental education at all levels—local, national, regional, and international—and for all age groups both inside and outside the formal school system" (https://www.gdrc.org/uem/ee/tbilisi.html).

BOTTOM LINE FOR PRACTICE

Progressions can be conceptualized in terms of strengthening environmental literacy in a variety of ways. Each of those have different implications for how a program might operate. We highlight some of the implications of progressions for EE programs and practices.

First, programs need to consider the scale of the progression. For instance, should a program focus on learning progressions to address participants' conceptual understandings of a topic, or on developmental progressions to target specific ages and stages?

Second, an environmental science learning progression may be useful for longer programs that include time to uncover students' initial conceptions and build on those conceptions in a specified way.

Relatedly, a third implication is that organizations that aim to promote environmental science conceptual understanding through a learning progressions framework might consider collaboration with additional organizations to support and deepen student domain learning at increasing grade levels.

Fourth, program educators may wish to avoid "doom-and-gloom" framing of environmental issues, especially for pre-adolescent children. In addition, according to the studies reviewed in this brief, EE programs for children under age 11 might focus on "connectedness to nature" concepts, which might increase the likelihood of pro-environmental action in adult life. As such, from a progressions perspective, programs for younger children should emphasize elements of free, unstructured play in their programming. As children move into adolescence, more formal, structured programming may be appropriate. In middle childhood (8–12 years), it is important to emphasize relationships with teachers, mentors, and other adults. Older teens (13–18 years) and young adults would benefit from programs that incorporate mastery experiences, such as learning about specific environmental issues at the community and regional scale as well as devising and implementing related, actionable solutions, that provide an opportunity for engaging youth in developmentally and socially appropriate ways.

Fifth and finally, despite the persistent assumption that a direct progression from awareness to action exists, research repeatedly shows that not to be the case. Numerous intervening factors influence each of the environmental literacy elements, which all exist within broader social and cultural contexts. While designing programs, it is, therefore, helpful to remember that targeting knowledge and attitudes alone does not automatically lead to pro-environmental actions and behaviors.

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