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The Use of Ecological Concepts in the Social Sciences: Measuring the Productivity, Durability & Resilience of Learning Ecosystems

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Abstract

Although superficially both the biological and the social sciences utilize ecological concepts, the biological sciences have applied systematic approaches and empirical methods to the study of these ideas while the social sciences have primarily utilized these same concepts in solely descriptive ways. Using the construct of ecosystems, we make the case for how social scientists in general, and researchers working in the learning sciences in particular could significantly benefit from adapting the analytical approaches pioneered within the biological sciences. In particular, we argue that significant insights would accrue if existing biological ecosystem frameworks such as productivity, durability and resilience were applied to the study of learning ecosystems.

Keywords: Ecosystem; Social science; Learning sciences; Productivity; Durability; Resilience

Introduction

Ecology is a relatively young science. Although its historical roots are quite deep, it was not until the second half of the 20th century that it became a separate and legitimate discipline within biology [1]. Ecology is the study of the myriad, complex interrelationships between and among living things and their environment, including how those interactions influence their survival. These ideas were early on adopted by another new discipline, the social sciences, with the earliest efforts to introduce ecological concepts found in the writings of Kurt Lewin [2]. However, four decades later noted psychologist, Urie Bronfenbrenner [3], utilized ecological constructs to formulate his Ecological Systems Theory and associated bio-ecological model. The model described how human development is influenced by myriad interactions between children and their environments, from the most immediate home ecological system, of parents and other influential adults, friends, and school, to the most expansive system which includes culture and society. Bronfenbrenner's metaphorical framing has proved particularly influential, forming the basis for thousands of peer-reviewed articles and reports, including a recent U.S. National Academies of Sciences consensus study on learning STEM outside of school [4,5].

Superficially, ecological concepts within both the biological and the social sciences appear quite similar. However, while the biological sciences have taken these "big ideas" and applied them in systematic and empirical ways that have yielded significant insights and predictions, the social sciences have by and large continued to use these ideas in primarily descriptive, metaphoric ways (as exemplified by the Bronfenbrenner model referred to above). This is particularly the case within the learning sciences – psychology and educational research – the fields in which we typically work.

Case Study: The "Ecosystem" Concept in the Learning Sciences

An increasing number of learning science researchers have begun using "ecological" perspectives in framing their work [4, 6-12], with the idea of a learning ecosystem becoming increasingly prevalent. The ecosystem concept is well suited to describing interactions between people and their environment, including processes for learning, and developing new knowledge in a variety of contexts [13]. Just as organisms in biological ecosystems interact with countless other species and resources

in their physical environment in order to survive and prosper [14], individual learners navigate a complex learning ecosystem comprised of cumulative experiences, across multiple learning platforms including classrooms, broadcast and print media, digital resources, and places like museums, in order to support their lifelong education, development and achievement goals [15-17]. Unfortunately, the learning ecosystem concept has again remained primarily a metaphor, rather than as an empirical tool for better understanding learning process and associated outcomes. We argue that social scientists in general and learning researchers in particular should focus on adapting the concepts, tools and models generated by biologists studying natural systems, to inform future investigations of the public's learning (pre-school children, school-aged children, university students, adults of all ages and backgrounds, families, etc.). Findings from the learning sciences will be sounder when research is framed in similar ways as the work that of ecologists, who study natural ecosystems through the lens of three key qualities: (1) Productivity [13,18,19]. (2) Durability/Persistence [20-23]. (3) Stability/Resilience [24-27].

Productivity

Understanding what, and how much an ecosystem "produces," is critical to understanding a system. The biological study of ecosystems was revolutionized by the consistent use and quantification of productivity measures such as energy [1], which allowed scientists not only to understand individual ecosystems, but enabled broad comparisons to be made across ecosystems. Within a learning ecosystem, the primary product is public learning. Efforts to understand how entire communities, even countries, support public learning have historically been significantly hindered by a limited view of where, when, how and with whom learning occurs [28], as well as the failure to adequately define learning. Although schooling is an important context for supporting learning, it is only one of many such contexts within the larger learning ecosystem and only accounts for a small portion of people's learning outcomes. In fact, substantial evidence indicates that the majority of learning and associated knowledge development for both children and adults is a result of participation in a variety of out-of-school learning opportunities [29]. Clearly definitions and quantification of learning outcomes, both affective (e.g., interest, motivation), cognitive (e.g., factual knowledge) and psycho-motor (e.g., skills and behaviors), are needed to measure the health and effectiveness of learning ecosystems and identify how and why some ecosystems are more productive than others.

Durability/Persistence

Healthy natural ecosystems are characterized by considerable durability and persistence which arises from intersecting relationships between aggregated species, rather than from the behaviors of any single individual. Therefore, measuring ecosystem durability requires that the entire system be studied as a whole rather than merely individuals or isolated parts of the system. This quality highlights a major problem with the approach of most learning researchers, even those espousing an ecological perspective. Most researchers continue to focus on either specific context, e.g., schools or media [30], and/or individual learners [6,31,32]. Although these many studies enrich understanding of how specific settings operate and how individual learners navigate the complexities of various settings in the system, the lack of conceptual integration between these studies makes it almost impossible to elucidate whole-ecosystem qualities such as durability. One promising exception has been to build on the use of complexity theory and agent-based modeling within natural ecosystems (cf., Boccarra, 2004), as a way to characterize the dynamic flows of people and learning across settings, social arrangements and over long periods of time [33,34]. Although still in its infancy, we believe such approaches promise to more accurately represent the realities of learning in the real world.

Stability/Resilience

As is true of biological ecosystems, more complex and highly integrated systems tend to be healthier and more resilient (e.g., Mahonge, 2010); the same is true of learning ecosystems. In learning ecosystems, complexity develops as the number of opportunities for learning increase, for example, individuals can learn about astronomy both in school and through out-of-school classes, websites and other online resources, books and magazines, museums, planetariums, and with television and other types of broadcast media. Resilience increases when this panoply of educational organizations and resources foster substantial collaboration and synergies within, and between themselves. As we discovered in our study of science education in the U.K. [7,8], collaboration between educational entities were common, but the relationships were generally limited in scope, inequitable and rarely sustained. For example, despite the fact that the overwhelming majority of science learning resources in the U.K. exist outside of school, and the fact that the vast majority of public time spent learning science happens outside of school, financial support and the framing of science learning policy, remains overwhelmingly directed at schooling. The fragility of this reality is being highlighted by the current COVID-19 pandemic. While formal education systems are primarily focused on how to continue offering classes while shut down, the public is left scrambling to find educational resources that will support their immediate, and more pressing need to learn how best to cope with a rapidly changing world. Those concerned with building a more robust and stable educational system for the future could benefit from utilizing established resilience protocols and metrics from the biological sciences in order to model and support creative solutions to improve learning ecosystems.

Conclusion

Significant progress has been made in the understanding of large complex biological systems by moving from purely metaphorical ways of describing systems, to models that are

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more rooted in solid definitions and robust metrics. The social sciences, in general, and research on learning, in particular, could significantly benefit from a similar evolution. Fortunately, social scientists need not invent these definitions and metrics from scratch. We believe the approaches used for studying complex biological systems could and should be adapted to the study of complex human systems such as learning ecosystems.

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