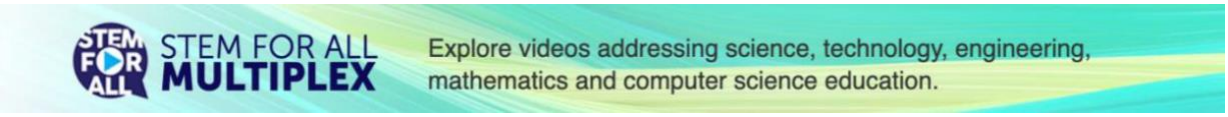

It Takes a Village: Using the Concept of "Learning Ecosystems" to Improve STEM Engagement
STEM for All Multiplex Theme of the Month Synthesis: October 2021

Introduction

Educators across the centuries have argued that children's learning will be richer and more valuable to them and their communities if it is seen as embedded in their whole lives, of which formal schooling is one, distinctive part.

In the 1970s, Ivan Illich argued that the relation of school and its surrounds should be radically reconceived. In the same decade, experiments flourished at the local level. For example, the Country Mile School, a Dewey-inspired school in Maine, was founded on the proposition that "every community has the resources to educate its children;" its founder acted as a broker and pedagogical mentor, as he enlisted lobstermen, craftspeople, farmers, housewives, and local college students and professors, to teach children from the island.

In the same decade, Uri Bronfenbrenner opened a new era in research on situated learning, by conceptualizing the child's development as an ecological process, with primary, secondary, and tertiary or distal elements, which interact with each other and either directly or indirectly influence the child's social and intellectual development. The ecological setting is thus where a child's identity begins to form, until the child's increasing agency and developing interests exert a reshaping effect upon the system. It is an idea that responds both to educational values, and to the increasing interest in reconstructing the experience of community.

In recent years, the idea of "learning ecosystems" has gained increasing value for science education in particular and reflects both the educational and social movements already mentioned, and its good fit with the pervasiveness and importance of science in all areas of our lives. Increased interest has stimulated experimentation and as the facilitator for the October Theme of the Month, Martin Storksdieck, said,

> *"[The idea of learning ecosystems] may have been very conceptual a while ago, but now it is actually a lived experience for many. It's a design principle and it is much more than just the complicated graph that I've been showing and others are showing. This is real. I think it changes the way we think about education."*

The Expert Panel

Dr. Martin Storksdieck, the Director of Oregon State University's STEM Research Center, and a professor in OSU's College of Education, assembled an expert panel whose members represent several different innovations in learning ecosystem design and research. Dr. Deborah L. Bailey serves as the STEM Education Specialist in the Office of Teaching, Learning and Assessment of the Oregon Department of Education. Dr. Nancy Staus is a Senior Researcher at Oregon State University's STEM Research Center and was previously a Research Associate in OSU's College of Education. Leigh Peake, Chief Education Officer at the Gulf of Maine Research Institute (GMRI).

To begin the conversation, Martin Storksdieck described the now-classic model of a learning ecosystem, which is rooted in the experience of an individual — in this case, his son, Jonas.

> *"From this vantage point, we recognize that, Jonas, is surrounded by caregivers, family, by peers, and later on, role models. He might have mentors, friends, people who influence him, and who influence, particularly, what he learns, how he learns, in what ways he learns, in which ways he identifies himself and develops identity and interests. These people are themselves surrounded and embedded into all sorts of institutions that are around Jonas, where he can take part in many different forms of STEM engagement, in this particular case, when we think about STEM learning ecosystems. And those are not just schools and after schools, but hobby clubs, the media is increasingly more important, including the blending of media and the internet... Museums and other forms of educational institutions, faith-based organizations, when they do sports, the library as a particular important component, lots of institutions that he can maneuver, and we can try and help him understand how to access and how to utilize this for his own learning."*

He then pointed out that there is yet a broader setting in the culture which includes community norms, social ties, and policy and funding agencies. Insight and innovation can be stimulated by transforming this "standard model" by placing different entities at the center. The three experts represent three such variations.

Deborah Bailey described one example of an ecosystem approach in Oregon, in which a governor's commission on STEM learning pathways led to the creation of STEM "hubs" (at present there are 13). These hubs, located around the state, identify institutions or activities that are part of the STEM learning landscape and seek ways to support and coordinate the links between them. For example, what role do schools play in the ecosystems being served by these hubs, and how can they complement (or be complemented by) the other science education stakeholders in the area. This involves trying "to get students better engaged in their community institutions and [get] teachers better engaged in how they follow up with [these community experiences] in the schools." As Bailey said,

> *"this is a transformational way of thinking how we can change education in the state, but yet we're also working within an established system. So how does this new ambitious way of thinking of how to change education in the state, fit within the system we have, or [determine] where the areas are in our system that we actually have to change."*

Such efforts, as Martin Storksdieck pointed out, create what are in effect "collective impact organizations" that change or create a new culture around science learning throughout the communities. The benefits of such a new culture are clear enough, but it can also conflict with currently existing activities — institutions with a clear and well-established mission, for example. Here as so much of educational change, one must rebuild the airplane while it is flying.

Nancy Staus discussed lessons learned from "SYNERGIES," a ten-year study which used an ecosystem approach to investigate and support youth STEM interest development and participation in science in a diverse, low-income community in Northeast Portland, Oregon. The project was motivated by the well documented decline of students' interest in STEM as they entered adolescence. As Staus pointed out, this is a phenomenon reported around the world. At this age, young people start to develop attitudes about their competence and areas of interest. The form in which they encounter science at this time often plays a strong role in shaping how science fits with their identity. As Staus remarked, the ecosystem approach,

"gave a different way of framing that problem… and trying to better understand how kids in a low income diverse community could navigate that ecosystem in order to develop their own unique pathways to STEM... The unique contribution of this project was the ability to see a STEM learning ecosystem from the eyes of the youth that were navigating that ecosystem."

The diversity of settings and representations of STEM in the community responded to the diversity of student interests and capacities, and found ways to construct their own pathways into science. After all, a key ingredient in good science education is the value placed on students' interests and intrinsic motivations to learn. This is in tension with programs set up to address a general need — for example, broadening access to computer science or digital skills. Individual learners will be drawn to some applications of coding, for example, but not others. One size does not fit all. Thus, the "village" mentioned in the title for this month's theme offers diverse pathways and entry points.

Leigh Peake described how the GMRI (Gulf of Maine Research Institute) ecosystem approach developed, starting from a very successful annual field trip for middle school students.

"When we took on [the ecosystem] lens, it meant we developed a lot of add-ons to that experience." Each of the innovations had the effect of coordinating elements of the learning ecosystem that GMRI was seeking to nurture, such as developing curriculum following on from the field trips, "to make sure the teachers had an opportunity to carry that field trip back into the classroom."

A digital field notebook enabled students to creation a portfolio of their field experiences, which helped them describe and demonstrate them to their parents — thus strengthening the parents' ability to participate in the ecosystem.

GMRI is extending this work by taking on a "backbone" role, helping to design or support local hubs, in which currently extant science learning resources make or strengthen explicit coordination or collaborations. Their work can be seen as "brokering," providing links between partners or stakeholders, and finding ways to make the links active and constructive. Given that each stakeholder has its own mission, funding mechanisms, and culture, the "brokers" need to be aware of the need for interpretation between different cultures. Their work represents a new opportunity for innovation — and for research on their backbone role, and on the ecosystems with which they work.

Recommendations for Researchers

As ecologists know very well, the creation of an artificial ecosystem can present unforeseen difficulties and interactions. In order to understand how to improve or change a "learning ecosystem," and given the diversity, much basic research is still needed to understand key indicators of system functioning. What kinds of observable outcomes or effects can be used to understand both how a learning ecosystem is functioning, and how well it is functioning for particular stakeholders — whether children, or community members, or participating institutions. Further, research is needed to understand both what elements of a system contribute to the function of the system, and what interaction effects may be shaping observable outcomes.

Recommendations for Administrators, Policymakers, and Teacher Leaders

While the "STEM learning ecosystem" as an intervention is still recent and not well theorized, it seems clear that taking steps to actively connect different STEM learning opportunities within a community can

both benefit students (and other humans) and support the work of schools and other learning institutions. Building connections requires patience, a willingness to experiment and sometimes fail, and the maintenance of consistent communications between partners. This is critical if each partner is to undertake the changes (or even re-design) necessary to make the systemic relationships durable.

One of the insights that Leigh Peake shared from GMRI's experience in Maine is that, at least in rural areas, everyone interested in STEM education needs to see themselves as "brokers," being on the lookout for connections between their work and other stakeholders in their community.

Ecosystems require energy; human ecosystems need both the fuel of interest and investment, and money. Policymakers may often play the role of funders, and of regulators in the system. This can result in power differentials between those who fund the work, and those who perform their share of the work. Therefore, at least in the first few years, research, evaluation, and accountability need to be strongly formative in flavor, giving useful, timely and practical feedback, questions, and constructive critique to the participants in the developing system, to support and enrich the sustained design and implementation efforts that will be necessary to attempt such a complex innovation.

Finally, with so many experiments being conducted around the country, researchers, policymakers, educators, and everyone else concerned with this approach to re-envisioning STEM learning needs to actively learn from reports of others' experiences, and to generate and disseminate clear descriptions and analyses of their own experiments, creating in effect an ecosystem of learning ecosystems.

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