Digital Teaching Networks Inspired by Astrobiology: Adaptive Scaling of High-Quality Learning Resources.
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Introduction. With the rise of computer-supported learning, including fully-online learning, there is a broad need for high-quality digital learning tools. These tools can be expensive and difficult to create, so they may not be widely available, particularly at community colleges. In addition, there are continuing pushes toward expanded adoption of empirically validated teaching practices, including replacement of lectures by discovery-based learning [1, 2].

Digital learning environments and pedagogical techniques are being developed to meet this need. The first waves of innovation centered on simulations (e.g., PhET), videos (e.g., Khan Academy), and Massively Open Online Courses - MOOCs (e.g., via Coursera and EdX). These open education resources democratize access, but are typically designed "top-down" from the vision of a single instructor, small team, company, or institution, and are not intended to be modified. The result is a barrier to adoption in diverse settings.

Adaptive scaling. A fundamentally new modality, adaptive scaling, complements adoption with adaptation by providing easy to use authoring platforms (e.g., Smart Sparrow and Acrobatiq). Courseware developed in such platforms can be customized for diverse student needs, individualized to instructors' visions, modified in response to feedback, distributed, and reused. It can also be designed, developed, deployed, and improved collaboratively, by digital teaching networks of instructors working with disciplinary experts and learning scientists.

Digital teaching networks. To maximize the value of these new digital capabilities, we are working to create digital teaching networks in which teachers can collectively use and adapt shared educational resources. Our vision is that a mature network will provide a suite of such resources, each with versions appropriate to common audiences represented by the participating teachers. For example, a middle school science resource could have additional challenges built in to better suite a high school audience, or a lesson built for a fully online course could have a version for an in-person computer lab setting.

Adaptive scaling through digital teaching networks offers clear benefits to students—better educational resources and more active learning. Teaching networks offer direct benefits to teachers as well. By providing a concrete model for effective active learning in the form of the existing lessons/course, the teaching network can serve as a professional development resource. In addition, the community of peers and potentially even peer review of adapted resources, provides a level of feedback that is very uncommon for teachers at the college level.

Data-driven improvements. A final benefit to this model of development and distribution of digital learning resources is access to powerful analytics and student data. Platforms such as Smart Sparrow's are capable of tracking a range of student behavior and question responses. These can be used by teachers and, with permission, across the teaching network to improve the quality of individual lessons.

Existing resources and networks in development. Astrobiology-related educational content is at the center of three developing teaching communities led by ASU and Smart Sparrow.

As part of the *NASA Exploration Connection* project, ASU and Smart Sparrow have launched the *Infiniscope* portal (http://infiniscope.org) to distribute a suite of formal and informal education experiences to aimed at middle school learners. These experiences emphasize authentic scientific reasoning skills in the. In-service teachers are currently involved through pilot testing and direct feedback. This relationship will continue as the network expands to address new and different uses of these resources.

Habitable Worlds, a fully-online college science course, has been taught by more than 30 instructors to date, reaching far beyond ASU as part of the *Inspark Teaching Network*. This course includes resources about a range of topics related to the search for life beyond Earth, focused on astronomy and geoscience. Some instructors have customized the course to fit local needs. These changes help to accommodate diverse use cases, ranging from fully online to entirely in-person and from whole course replacement to supplemental material.

BioBeyond, another fully-online college science course distributed by *Inspark*, provides a suite of educational resources appropriate for introductory biology, strongly inspired by astrobiology. It is nucleating a new and rapidly growing community of biology faculty.

These examples represent only the first stages of what we see as a potentially transformative model for development in digital education.

References: [1] Singer et al. (2012) *Discipline-based education research*. [2] PCAST (2012) *Engage to Excel.*