Fostering and Sustaining Interdisciplinary Faculty Communities Around Undergraduate Teaching: Insights from the QUBES Project

Part of the SIAM Ed Communities of Practice for Math Modeling Education symposium.

Sam Donovan
University of Pittsburgh
Are our current reform efforts just rearranging the deck chairs on the Titanic?
Does the Biology we Teach Reflect the Biology we Do?

Explosive growth of information – Quantitative

Expanding role of technology – Computational

Changes in the nature of the discipline - Interdisciplinary

Bridging school and the real world – Connected to students
Outline for the talk

What is QUBES?

What are the core pedagogical commitments?

How and why an emphasis on community?
Outline for the talk

What is QUBES?

What are the core pedagogical commitments?

How and why an emphasis on community?
As an scientific gateway for education we:

- Focus on big challenging problems
- Mobilize a community
- Coordinate activities
- Support collaboration
- Provide key resources
Sam Donovan (PI – DUE-1446269; and Director of Collaborative Projects
DUE-1446258 (PI – LaMar, College of William and Mary),
DUE-1446284 (PI – Gower, University of Wisconsin-Madison).
+ many other key collaborators

Collaborative Research: BIO IUSE Ideas Lab: Supporting Faculty in Quantitative Undergraduate Biology Education and Synthesis (QUBES).

qubeshub.org/
The “Last Mile” Problem
Access to quality content is generally perceived as the key barrier to getting more quantitative reasoning into biology.
The real barrier to getting more quantitative reasoning into biology

Faculty need support to:

- Develop their own skills and confidence, particularly around pedagogical content knowledge.
- Customize resources for use in their own specialize teaching setting, with their particular student audience.
Faculty mentoring networks are:

- Online groups, typically 10-15 faculty members
- Focused on a specific topic or material
- Typically meet every two weeks over a period of several months
- Led by teams of expert content and pedagogy mentors

The benefits of participating in a faculty mentoring network include:

- Interacting with colleagues across the country who are teaching similar courses
- Discovering new teaching materials and incorporate them into your courses
- Learning about new pedagogical techniques proven to be effective in the classroom
- Becoming more comfortable incorporating quantitative content into your biology courses
- Providing evidence of your professional activities to your department

Take a peek at upcoming Fall 2018 Faculty Mentoring Networks hosted by our partners on QUBES. Click on the FMN for more details.
Situated learning (Lave & Wenger, 1991)
“learning is an integral part of generative social practice in the lived-in world” (p. 35)

Through legitimate peripheral participation

Community of Practice (Wenger, 1998)
Social theory of learning – “learning…changes who we are by changing our ability to participate, to belong, to negotiate meaning” (p. 266)

Mutual engagement, joint enterprise, and shared repertoire

serc.carleton.edu/earth_rendezvous/2016/program/talks/mondayB/136530.html
Open Education Resources

**Old model**
- Polished materials
- Repositories
- Teaching as private practice

**New model**
- Always beta
- Living documents
- Teaching as scholarship
Original published TIEE Module
12 derivative versions
shared by FMN participants

Implemented in Lecture

Implemented in Lab & Lecture

Implemented in Lab
Professional recognition and tracking scholarly Impact

Kerry Byrne
Oregon Institute of Technology

Kerry is an assistant professor in the Natural Sciences Department at Oregon Institute of Technology. There, she teaches courses in general biology as well as upper division courses in plant ecology, evolution, and botany. She received her B.S. in Environmental Biology in 2004 from the University of California, Davis, then worked as a plant ecologist for an environmental consulting firm before receiving her PhD in Ecology in 2012 from Colorado State University. Her research interests include global change biology and plant conservation, in addition to student learning, attitudes, and confidence in STEM education.

Module: Investigating the footprint of climate change on phenology and ecological interactions in north-central America

http://ecoed.esa.org/index.php?P=FullRecord&ID=539
https://qubeshub.org/collections/post/1480

April Conkey
Texas A&M University-Kingsville

I'm an Assistant Professor in the Department of Animal, Rangeland, and Wildlife Sciences at Texas A&M University-Kingsville. I earned B.S. and M.S. degrees in biology from Texas A&M-Kingsville and a Ph.D. degree in Wildlife and Fisheries Sciences from Texas A&M University, College Station. My research focuses on wildlife ecology, human dimensions, and education and outreach. I teach undergraduate level courses on Principles of Wildlife Management, Wildlife Management Techniques, Human-Wildlife Conflict Resolution, and a graduate level Teaching Methods course.

Module: Exploring the population dynamics of wintering bald eagles through long-term data

http://ecoed.esa.org/index.php?P=FullRecord&ID=320
Science gateways are a community-specific set of tools, applications, and data collections that are integrated together via a web portal or a desktop application, providing access to resources and services of distributed computing infrastructures.
We offer partners turn-key web 2.0 infrastructure

Here you can find modules that use image analysis to capture student's interest and teach quantitative skills in an engaging way. The idea is simply to use fascinating pictures and real biological research stories to motivate students to learn the quantitative skills they need.

- **Leaf cutter ant foraging**
  Students learn linear regression while studying foraging behavior of leaf cutter ants from the rainforests of Panama. (Open inquiry)

- **3D breast cancer tissue reconstruction**
  Students learn how modeling complements empirical work, and about histograms, cross-correlation, and/or diagnostic error rates by reconstructing breast cancer tissues in three dimensions. (Retrace path of scientific discovery)

- **Dendroclimatology**
  Students learn linear regression and exponential functions while studying the relationship between climate and tree growth, using tree ring analysis. (Open inquiry)

- **Phenotypic plasticity and predation**
  Students learn about experimental design and ANOVA while examining plasticity in tadpole development under different predator regimes. (Open inquiry)
Running Computational Tools

No software installation required, instructors can direct students directly to the material

R-Studio IDE for R

RStudio is a GUI for R, the statistical programming language.

Launch RStudio | RStudio page

Links of interest:

Using R in the Classroom

Copasi

COBRA is a software application for simulation and analysis of biochemical networks and their dynamics. COBRA is a stand-alone program that supports models in the SBML standard and can simulate their behavior using ODEs or Gillespie's stochastic simulation algorithm; arbitrary discrete events can be included in such simulations.

COBRA carries out several analyses of the network and its dynamics and has extensive support for parameter estimation and optimization. COBRA provides means to visualize data in customizable plots, histograms and animations of network diagrams.

Launch Copasi | Copasi page

NetLogo

NetLogo is a multi-agent programmable modeling environment. It is used by tens of thousands of students, teachers and researchers worldwide.

Launch NetLogo | NetLogo page

Links of interest:

Using NetLogo in the Classroom

QtOctave

From the GNU Octave Wikipedia page:

Octave is a high-level programming language, primarily intended for numerical computations. It provides a command-line interface for solving linear and nonlinear problems numerically, and for performing other numerical experiments using a language that is mostly compatible with MATLAB. It may also be used as a batch-oriented language. As part of the GNU Project, it is free software under the terms of the GNU General Public License.

Octave is an open-source Qt front-end application for GNU Octave.

Launch Octave | Octave page

ImageJ

ImageJ is a public domain Java image processing program inspired by NIH Image for the Macintosh. It runs, either as an online applet or as a downloadable application, on any computer with a java 1.4 or later virtual machine. downloadable distributions are available for Windows, Mac OS, Mac OS X and Linux. It can display edit, analyze, process, save and print files, 16-bit and 32-bit images. It can read many image formats including TIF, GIF, JPEG, BMP, PCX, FITS and "raw". It supports "plugins", a series of images that share a single window. It is multi-threaded, so time-consuming operations such as image file reading can be performed in parallel with other operations.

Launch ImageJ | ImageJ page

Mesquite

Mesquite is modular, extensible software for evolutionary biology, designed to help biologists organize and analyze comparative data about organisms. Its emphasis is on phylogenetic analysis, but some of its modules concern population genetics, while others do non-phylogenetic multivariate analysis. Because it is modular, the analyses available depend on the modules installed.

Mesquite also has many features for managing and processing data, including processing of clades, sequence alignment, editing of morphometric data, and others.

Launch Mesquite | Mesquite page
Ways that QUBES facilitates research

**Student Research**
- Promoting learning environments to reflect practice
- Lowering barriers to the use of data and modeling tools
- Collaborations among courses

**Implementation Research**
- Studying the features of QUBES faculty development strategies that influence implementation success

**QUBES HUB as a Research Platform**
- We invite proposal to study communities or activities that take place around the QUBES Project.
Outline for the talk

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How and why an emphasis on community?
32 years young!

- Problem Posing
- Problem Solving
- Peer Persuasion
Using real data will expose students to the messiness of real world problems.

Selecting applications with broad impact makes instruction more compelling, helping to attract and retain students.

Teaching commonly used current methods will prepare them for the workplace.

Working in teams

Data Acumen - the emergent skills and habits of mind that “enable data scientists to make good judgments and decisions with data.”
Productive Disciplinary Engagement

The design of learning environments that support:

- **Problematizing** – students are encouraged to take on intellectual problems in the subject.
- **Authority** – students are given authority to participate by contributing knowledge.
- **Accountability** – students' intellectual work is made accountable to other using disciplinary norms.
- **Resources** – students are given sufficient resources to participate this way.

Guiding Principles for Fostering Productive Disciplinary Engagement: Explaining an Emergent Argument in a Community of Learners Classroom
Outline for the talk

What is QUBES?

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Productive Disciplinary Engagement (teachers)

The design of learning environments that support:

- **Problematizing** – teachers are encouraged to take on intellectual problems in the subject.
- **Authority** – teachers are given authority to participate by contributing knowledge.
- **Accountability** – teachers' intellectual work is made accountable to other using disciplinary norms.
- **Resources** – teachers are given sufficient resources do participate this way.

Guiding Principles for Fostering Productive Disciplinary Engagement:
Explaining an Emergent Argument in a Community of Learners Classroom
Efforts to improve undergraduate STEM teaching methods have generated many great ideas and materials, but few have caught on.

The 2014 NSF IUSE Program Solicitation states that “transferability and propagation are critical aspects for IUSE-supported efforts and should be addressed throughout a project’s lifetime by ensuring attention to designing for use in a large variety of institutions.”

Very few developers currently do this in their proposals, because, in large part, they aren’t sure how.
Supporting faculty in the adoption of open education scholarship requires the integration of tools, workshops, and existing communities in a way that fits faculty needs.
Overview

For modern life science researchers, high-throughput approaches can open the doors to discovery of novel genes, drugs, and regulatory networks. The effective design, implementation, and analysis of high-throughput research require fundamental quantitative skills. Taken together, the opportunity for new modes of discovery and development of associated quantitative skills make integration of high-throughput research into college biology curricula highly attractive. Yet, the high cost and technological demands of high-throughput discovery prohibit its use in most college laboratories. To address this need, this Research Coordination Network in Undergraduate Biology Education (RCN-UBE) seeks to improve student quantitative skills and participation in high-throughput discovery. Researchers and teaching fellows in the network will learn about high-throughput technologies and work together to create novel case studies that will demystify high-throughput approaches and promote discovery science to reinforce cornerstone STEM concepts and quantitative skills in the college classroom.
DIG: Designing an infrastructure and sustainable learning community for integrating data-centric resources in undergraduate biology.

Bringing Research Data to the Ecology Classroom: Opportunities, Barriers, and Next Steps
The NIBLSE community is coordinating an effort to collect, customize, and disseminate high quality bioinformatics learning resources. Below is a collection of Bioinformatics Learning Resources including NIBLSE Incubators and CourseSource Bioinformatics resources.

NIBLSE is working with the Quantitative Undergraduate Biology Education & Synthesis Project (QUBES) to establish learning resource “incubators” to nurture the development and dissemination of promising lesson materials.

All learning resources have been reviewed and assigned NIBLSE Core Competencies. To see a full description, click the competency or visit the NIBLSE Core Competency page.

Click the icon to the right to download a guide on how to navigate a QUBES Database:
Biodiversity Literacy in Undergraduate Education

ABOUT

PRODUCTS

RECENT ACTIVITY

Anna Monfils - PI
Beanbag Toss (Grades 6-8)

By Jody Britten¹, Marka Carson, Jacob Cordeiro, Misael Jiminez², Erika Villegas-Jiminez¹

Pomona Unified School District, CA

The classroom lesson presents students with the task of developing a fair--yet challenging--beanbag toss game.

Listed in Teaching Materials | resource by group Math Modeling Hub
Explosive growth of information – Quantitative

Expanding role of technology – Computational

Changes in the nature of the discipline - Interdisciplinary

Bridging school and the real world – Connected to students
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Funding: National Science Foundation
DUE 1446269, DUE 1446284
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