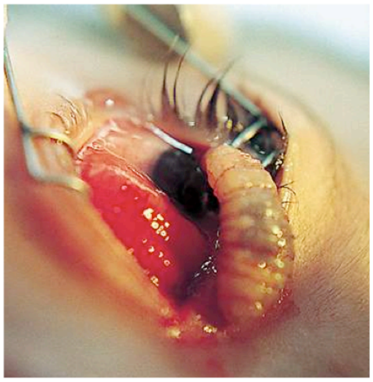
Using gross parasites to sneak even grosser equations

$$\Pr(X = k) = \binom{k-1}{k-r}(1-p)^r p^{k-r}$$

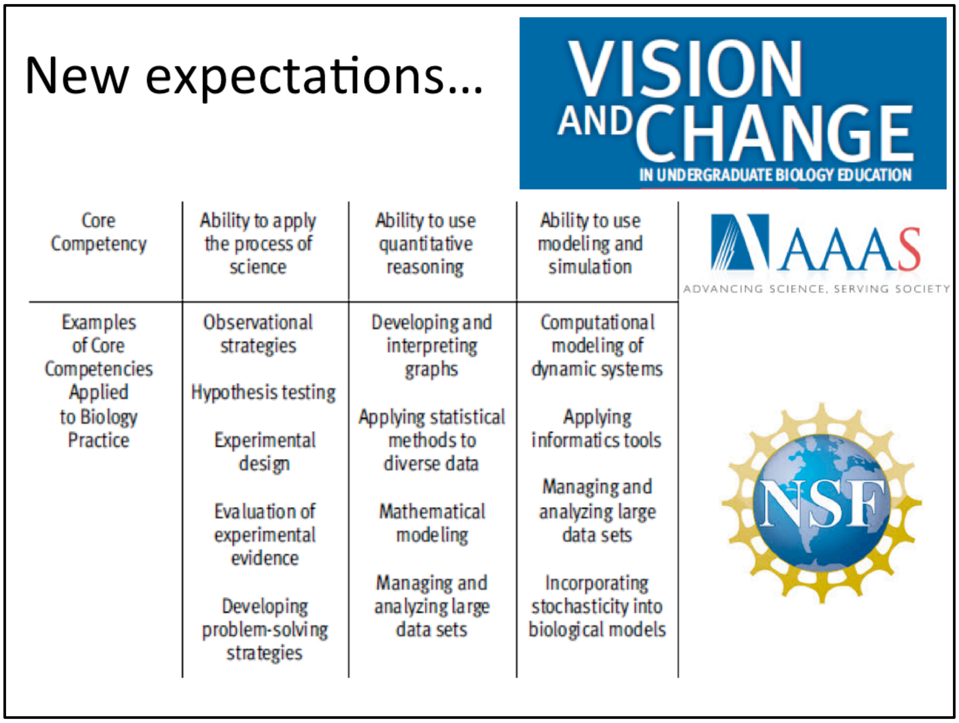
…into the introductory biology classroom



Jeremy Wojdak

D Lamar@ College of William and Mary
K Jenkins @ BioQUEST Curric. Consortium
T Gower @ North Carolina SU
R Sheehy & A Fleming-Davies @ Radford U.
S Donovan & A Hale @ U of Pitt.
C Diaz Eaton@ Unity College
DB Poli @ Roanoke College

THANKS!



New expectations…

VISION AND CHANGE
IN UNDERGRADUATE BIOLOGY EDUCATION

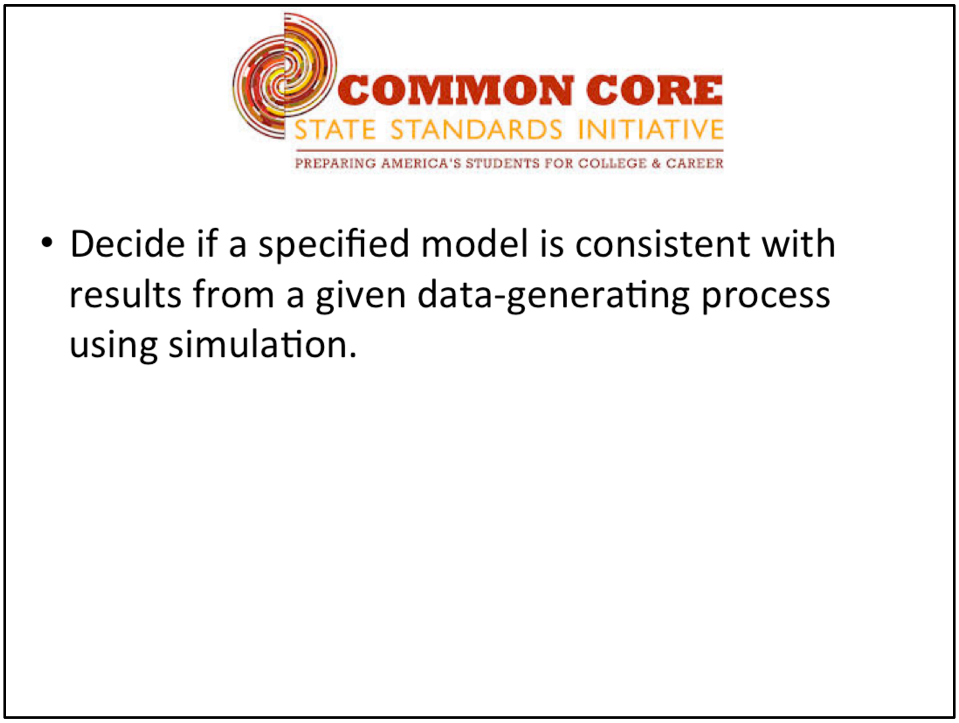
Core Competency	Ability to apply the process of science	Ability to use quantitative reasoning	Ability to use modeling and simulation
Examples of Core Competencies Applied to Biology Practice	Observational strategies Hypothesis testing Experimental design Evaluation of experimental evidence Developing problem-solving strategies	Developing and interpreting graphs Applying statistical methods to diverse data Mathematical modeling Managing and analyzing large data sets	Computational modeling of dynamic systems Applying informatics tools Managing and analyzing large data sets Incorporating stochasticity into biological models

AAAS
ADVANCING SCIENCE, SERVING SOCIETY

NSF

College faculty that teach introductory courses often struggle to strike a successful balance between covering the requisite content, introducing students to the array of scientific skills they will need, and maintaining the student's interest. Mathematics, modeling, simulation, and statistics are all more important for a successful career in science than ever, yet in most schools the curriculum hasn't kept pace with the changing demands

Just to point out how much things have changed, here from 2010 are some of the expectations from the AAAS and NSF V&C report on what biology education needs to look like, given what professional biologists are doing. 3 of 6 core competencies are quantitative….



COMMON CORE
STATE STANDARDS INITIATIVE
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER

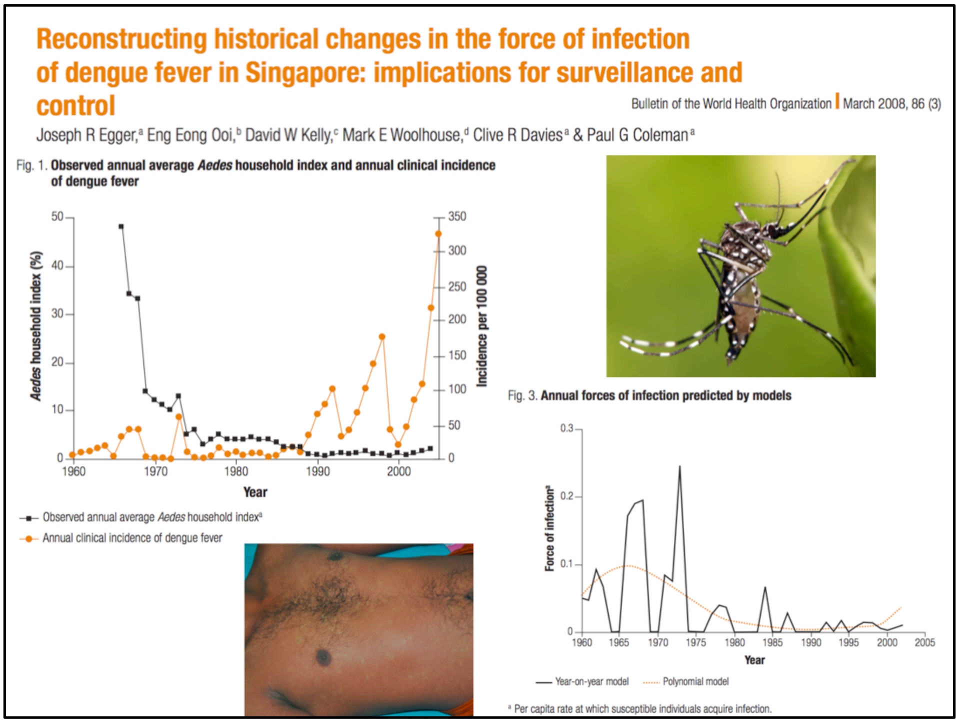
- Decide if a specified model is consistent with results from a given data-generating process using simulation.

Look at these new proposed standards for high school students in stats/probability… for EVERYONE.

If you are like me and you think back to your high school and even college curriculum….

That sophisticated and nuanced understanding of quantitative methods was not part of high school or even college.

So things are changing in the undergrad classroom. I'd like to propose that as parasitologists we have a great opportunity to contribute to the solutions for the problems that face faculty and departments that are modernizing their curriculum. We can tell stories where the outcome of the modeling or analyses are really, really important… and connect with ecology types and medical types. Importantly, we don't have to artifical stuff quantitative methods into our stories… they fit in naturally. They are what we do. We have these excellent teaching opportunities… and we can take advantage of them to accomplish something else….



Reconstructing historical changes in the force of infection of dengue fever in Singapore: implications for surveillance and control

Bulletin of the World Health Organization | March 2008, 86 (3)

Joseph R Egger,[a] Eng Eong Ooi,[b] David W Kelly,[c] Mark E Woolhouse,[d] Clive R Davies[a] & Paul G Coleman[a]

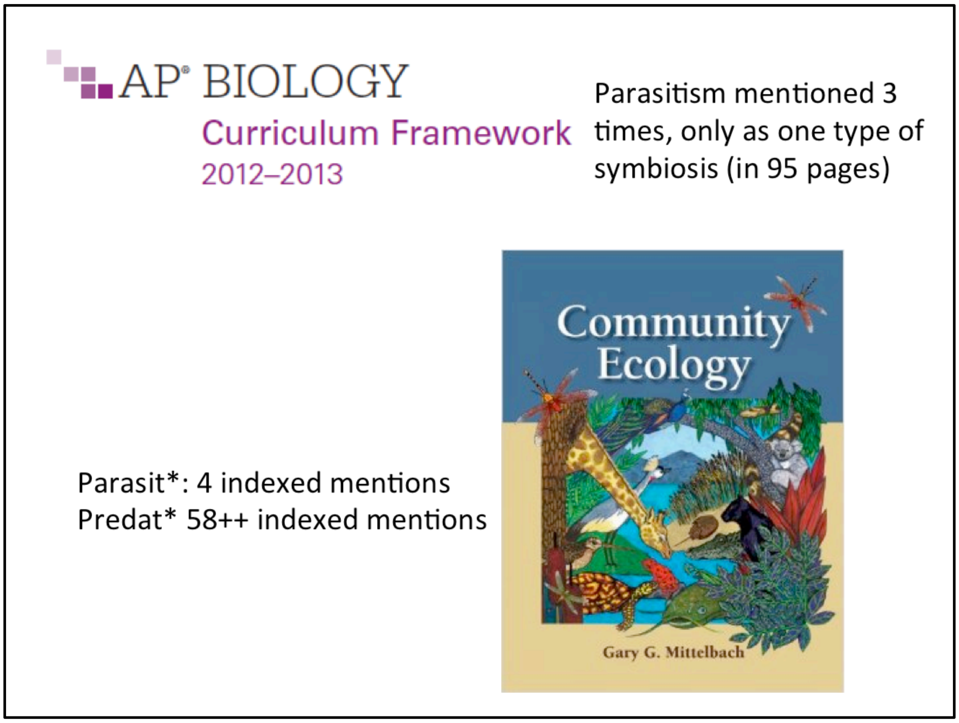
Fig. 1. **Observed annual average *Aedes* household index and annual clinical incidence of dengue fever**

Aedes household index (%)
0
10
20
30
40
50
Incidence per 100 000
0
50
100
150
200
250
300
350
1960
1970
1980
1990
2000
Year
Observed annual average *Aedes* household index[a]
Annual clinical incidence of dengue fever

Fig. 3. **Annual forces of infection predicted by models**

[a] Per capita rate at which susceptible individuals acquire infection.

Since time immemorial, math has been a big part of parastiology, epidemiology and disease ecology. The foundational models have penetrated pretty broadly into the curriculum – people teach SIR models in lots of courses and contexts… Many of you have deep roots using models to understand data.



AP® BIOLOGY
Curriculum Framework
2012–2013

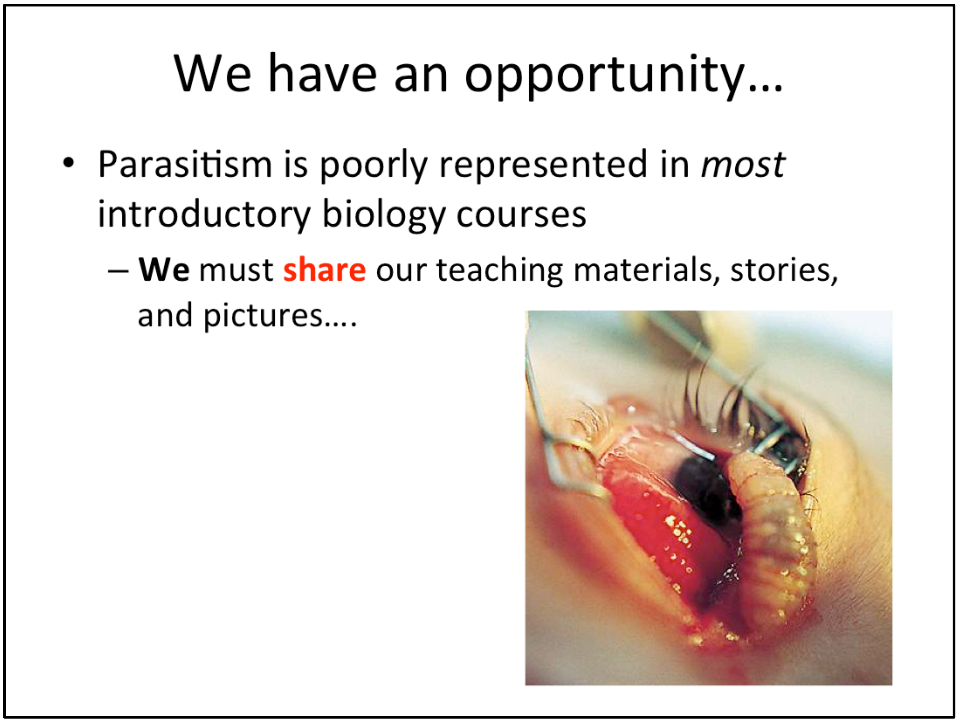
Parasitism mentioned 3 times, only as one type of symbiosis (in 95 pages)

Community Ecology
Gary G. Mittelbach

Parasit*: 4 indexed mentions
Predat* 58++ indexed mentions

By some estimates 40-50% of species are parasitic… yet, in the AP bio curriculum doc of 95 pages, parasitism is only mentioned 3 times, and just as a defintition. In Gary Mittelbach's community ecology text, which is clearly much more focused on topics that should involve parasitism… parasites only 4 times preadtion almost 60… excluding topics involving "prey"…

But the point is simple – parasitism gets short shrift in most undergraduate biology curricula, compared to its ubiquity in nature.

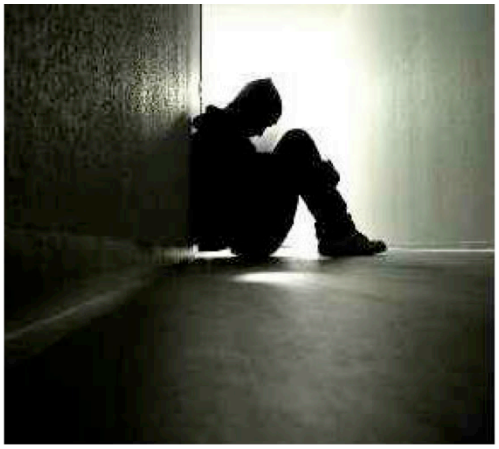


We have an opportunity…

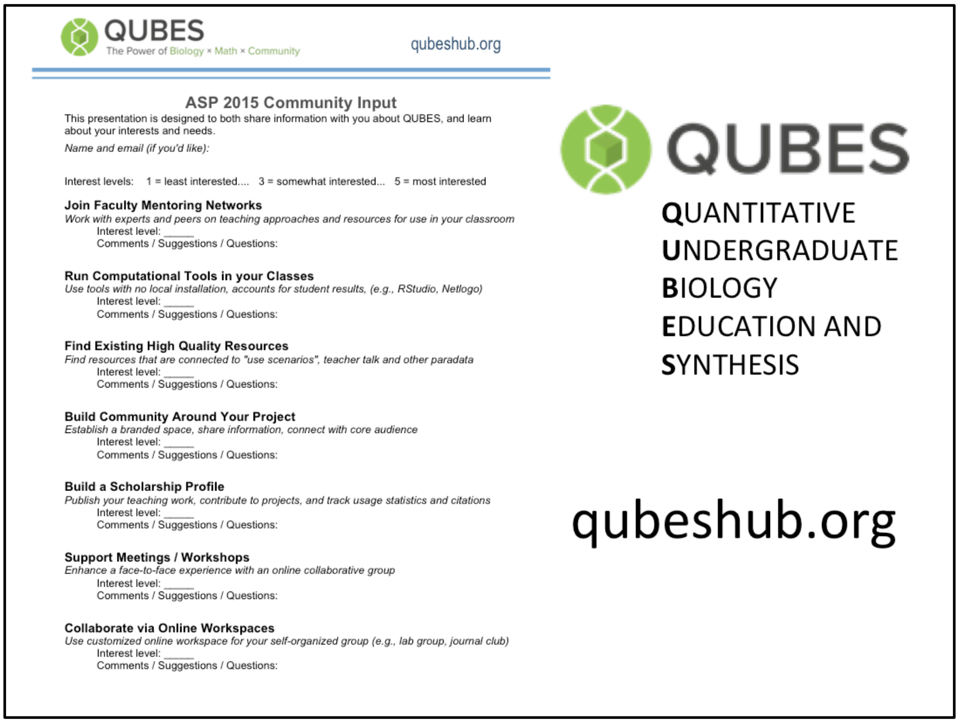
- Parasitism is poorly represented in *most* introductory biology courses
  - **We** must **share** our teaching materials, stories, and pictures….

The question is – how can we improve our own teaching but also share what we have to offer with the larger group of faculty teaching intro bio?

Instructor



This sharing or collaboration is really not trivial. There are hundreds of intro bio teachers out there, who never talk to each other… Being a teacher can be a lonely prospect… here I am crying in a hallway after looking at their first exam grades…



QUBES
The Power of Biology × Math × Community

qubeshub.org

ASP 2015 Community Input

This presentation is designed to both share information with you about QUBES, and learn about your interests and needs.

Name and email (if you'd like):

Interest levels: 1 = least interested.... 3 = somewhat interested... 5 = most interested

Join Faculty Mentoring Networks
Work with experts and peers on teaching approaches and resources for use in your classroom
Interest level: _____
Comments / Suggestions / Questions:

Run Computational Tools in your Classes
Use tools with no local installation, accounts for student results, (e.g., RStudio, Netlogo)
Interest level: _____
Comments / Suggestions / Questions:

Find Existing High Quality Resources
Find resources that are connected to "use scenarios", teacher talk and other paradata
Interest level: _____
Comments / Suggestions / Questions:

Build Community Around Your Project
Establish a branded space, share information, connect with core audience
Interest level: _____
Comments / Suggestions / Questions:

Build a Scholarship Profile
Publish your teaching work, contribute to projects, and track usage statistics and citations
Interest level: _____
Comments / Suggestions / Questions:

Support Meetings / Workshops
Enhance a face-to-face experience with an online collaborative group
Interest level: _____
Comments / Suggestions / Questions:

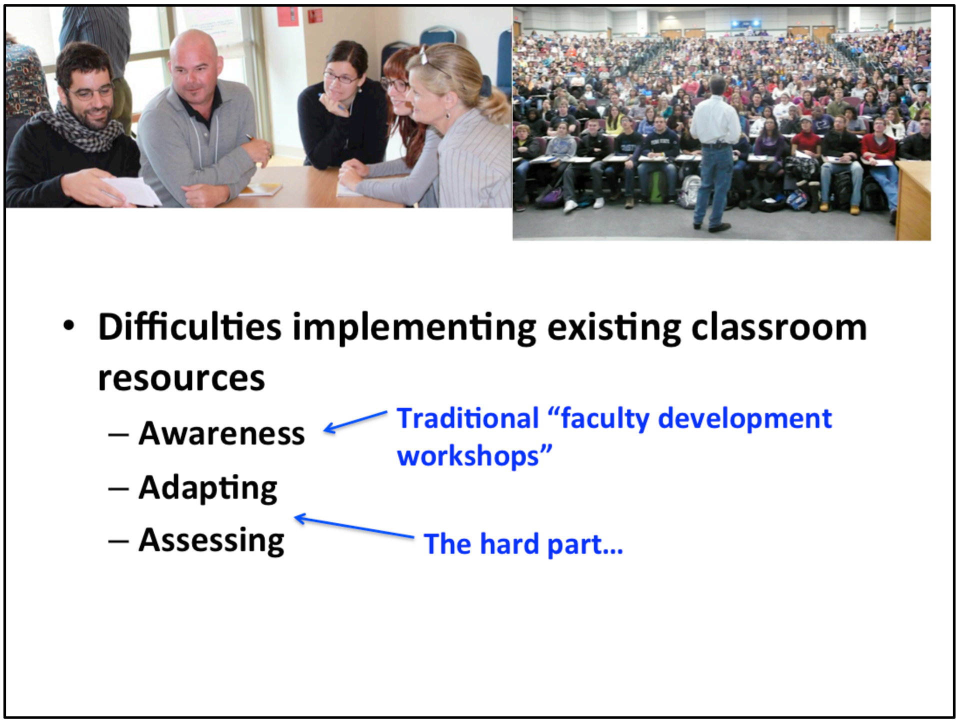
Collaborate via Online Workspaces
Use customized online workspace for your self-organized group (e.g., lab group, journal club)
Interest level: _____
Comments / Suggestions / Questions:

QUBES

QUANTITATIVE
UNDERGRADUATE
BIOLOGY
EDUCATION AND
SYNTHESIS

qubeshub.org

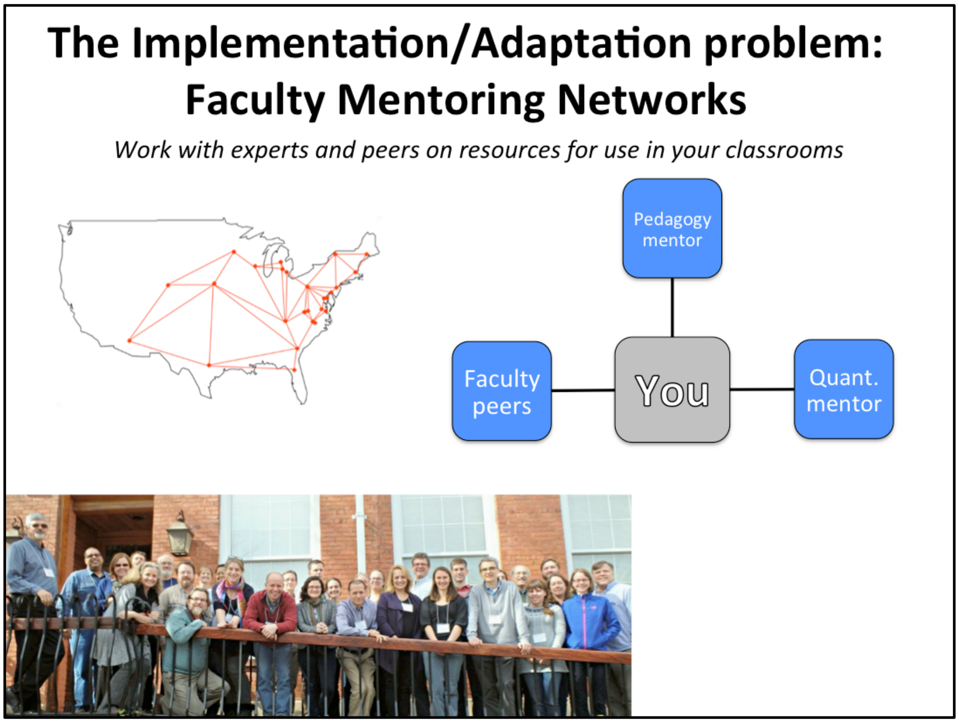
So I want to tell you about a project whose real purpose is just to get more quantitative biology into the classrooms. called QUBES. There are LOTS of great projects, resources, people working on this problem… what we sought was to find ways to make all this more effective, efficient, and more collaborative –where are the rate limiting steps…? and how can we help people find, use, and share?



- **Difficulties implementing existing classroom resources**
  - **Awareness** ← **Traditional "faculty development workshops"**
  - **Adapting**
  - **Assessing** ← **The hard part…**

It seems that one real difficulty is adapting those to the unique situation in your class, assessing whether the new approach is working, that the real challenge for faculty. Existing faculty development workshops where one person shares what they do, and prepares the participants with materials to take home and try is great… but that mostly addresses the first part of the process – finding the resource and becoming familiar with it.

The hard part is still to be done… learning the software, adapting the instruction to the unique student body, classroom, resource constraints… adapting to the instructor themselves … and figuring out if it worked, or what to do differently next time.



The Implementation/Adaptation problem: Faculty Mentoring Networks

Work with experts and peers on resources for use in your classrooms

Pedagogy mentor

Faculty peers

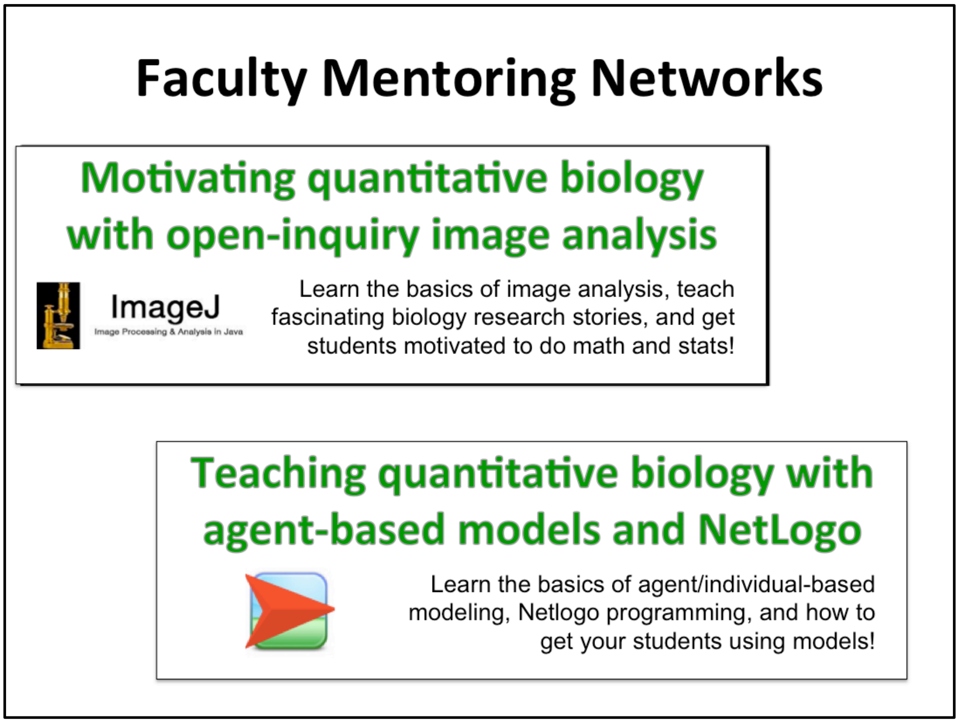
You

Quant. mentor

We recognized that typical faculty development, 1 or 3 day workshops where you get materials and talk about how to teach are great, but what normally happens is you leave motivated, and 3 months later when it comes time to use those new approaches in your own courses, you struggle with the very hard problems of local adaptation and implementation. How do I take someone else's materials and make them work in my course?

Our solution is to create ongoing faculty mentoring networks that match faculty working on similar problems with pedagogy and content experts DURING the implementation phase… while you are teaching you can get help, talk with peers, share stories, share modified resources… we do this by leveraging collaborative online workspaces.

This is not just about making these easier for the learners, but for the teachers. Imagine you have an NSF grant and promised outreach – this can get your research into classrooms… what better way than connecting with 10-12 faculty around the country that sign up just to get new stuff into their classes…



Faculty Mentoring Networks

Motivating quantitative biology with open-inquiry image analysis

ImageJ
Image Processing & Analysis in Java

Learn the basics of image analysis, teach fascinating biology research stories, and get students motivated to do math and stats!

Teaching quantitative biology with agent-based models and NetLogo

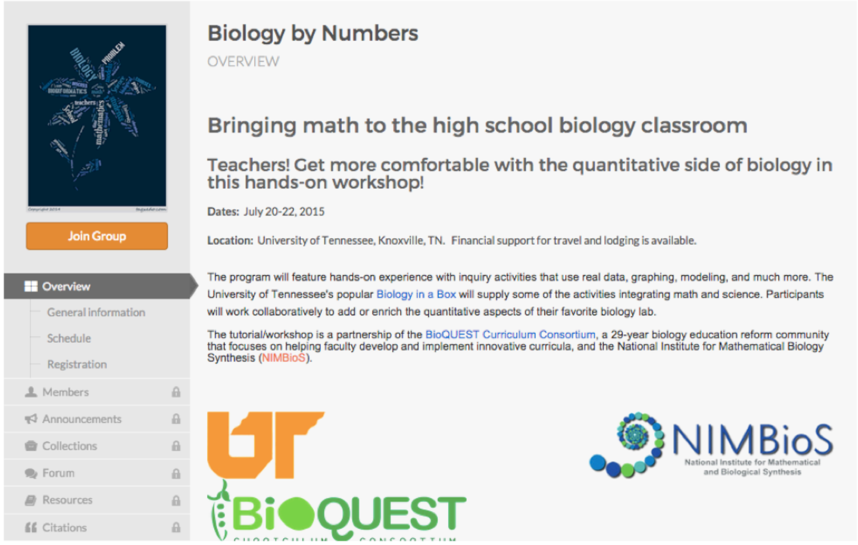
Learn the basics of agent/individual-based modeling, Netlogo programming, and how to get your students using models!

This year at ESA we are kicking off a FMN to use real data in the classroom, organized by the folks at the Dryad Data Repository… experts in big data and people experienced with using big data in the classroom leading novices.

I am organizing a FMN around agent based models and netlogo to be launched this fall…

The awareness problem:
Build Community Around Your Project

Establish a branded space, share information and collaborate with users.



Biology by Numbers

OVERVIEW

Bringing math to the high school biology classroom

Teachers! Get more comfortable with the quantitative side of biology in this hands-on workshop!

Dates: July 20-22, 2015

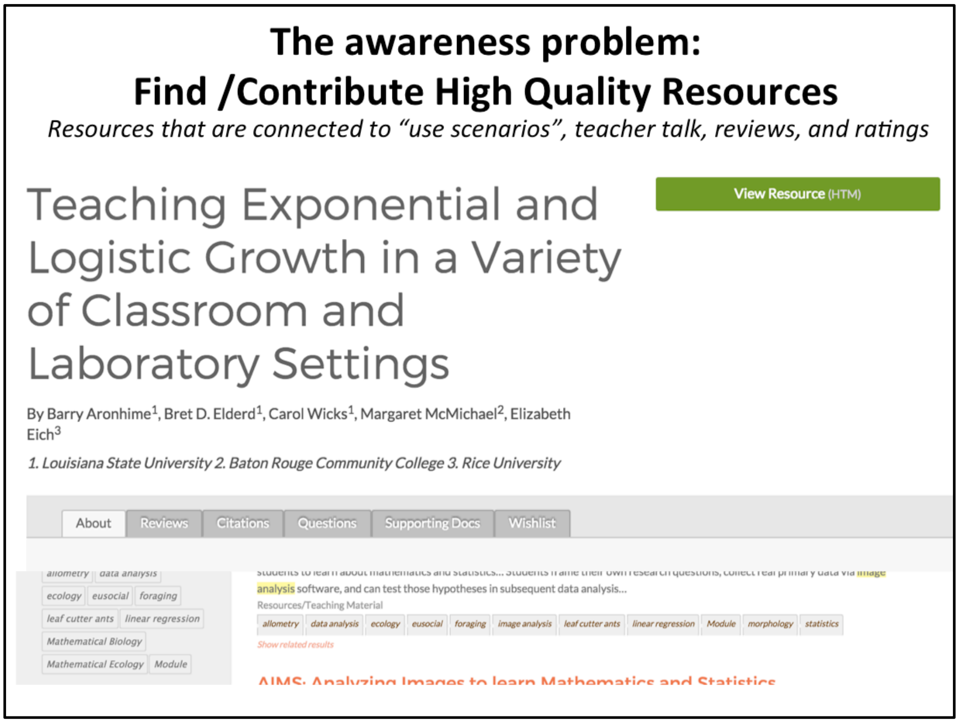
Location: University of Tennessee, Knoxville, TN. Financial support for travel and lodging is available.

The program will feature hands-on experience with inquiry activities that use real data, graphing, modeling, and much more. The University of Tennessee's popular Biology in a Box will supply some of the activities integrating math and science. Participants will work collaboratively to add or enrich the quantitative aspects of their favorite biology lab.

The tutorial/workshop is a partnership of the BioQUEST Curriculum Consortium, a 29-year biology education reform community that focuses on helping faculty develop and implement innovative curricula, and the National Institute for Mathematical Biology Synthesis (NIMBioS).

On qubeshub, projects can have a face and presence explicitly tied in to this vibrant community of users that are coming to the site…we are also working to have automation where if you update your personal site, the QUBES version gets those updates automatically.

Again, the idea is to join in a centralized community of people working on the same stuff…



The awareness problem:
Find /Contribute High Quality Resources

Resources that are connected to "use scenarios", teacher talk, reviews, and ratings

Teaching Exponential and Logistic Growth in a Variety of Classroom and Laboratory Settings

View Resource (HTM)

By Barry Aronhime[1], Bret D. Elderd[1], Carol Wicks[1], Margaret McMichael[2], Elizabeth Eich[3]

1. Louisiana State University 2. Baton Rouge Community College 3. Rice University

About | Reviews | Citations | Questions | Supporting Docs | Wishlist

allometry *data analysis* *ecology* *eusocial* *foraging* *leaf cutter ants* *linear regression* *Mathematical Biology* *Mathematical Ecology* *Module*

students to learn about mathematics and statistics... Students frame their own research questions, collect real primary data via image analysis software, and can test those hypotheses in subsequent data analysis...

Resources/Teaching Material

allometry *data analysis* *ecology* *eusocial* *foraging* *image analysis* *leaf cutter ants* *linear regression* *Module* *morphology* *statistics*

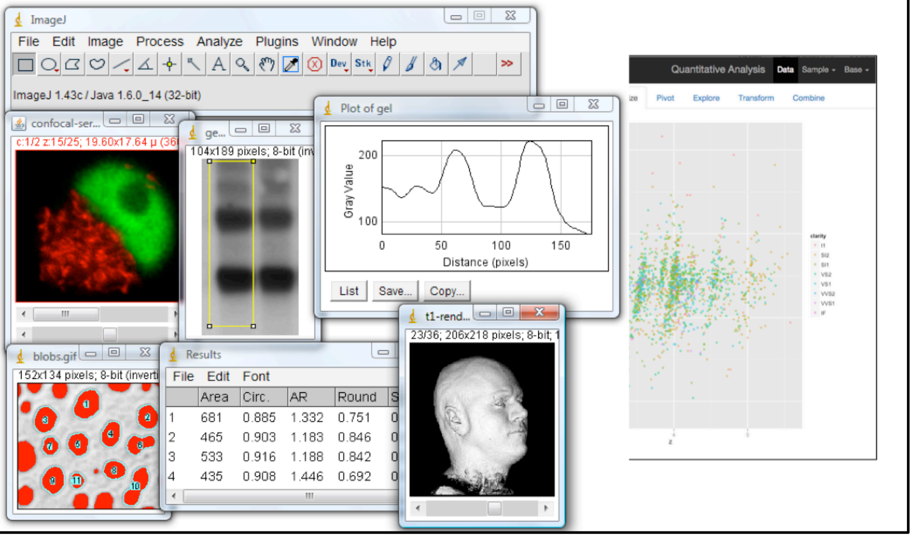
Show related results

AIMS: Analyzing Images to learn Mathematics and Statistics

Another way QUBES is hoping to facilitate these needed reforms is by collecting and curating collections of high quality teaching resources. This has been tried a bunch of times.. NSDL, etc… but we are hoping to add a few nice features like high quality search algorithms, meaningful tagging, search results by user ratings (i.e. find the best stuff first)…. And also by providing space for users of resources to make comments, ask questions of the authors, upload their modified versions, and share teaching stories and use scenarios. Ideally we can capitalize on the power of social media interactions around teaching resources…

Logistical problems:
Running Computational Tools

No local software installation required, instructors can get students interacting with data and models more quickly and in user-friendly environments

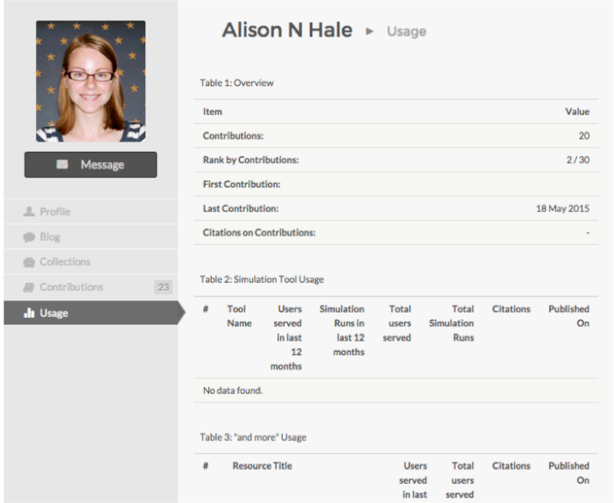

ImageJ
File Edit Image Process Analyze Plugins Window Help
ImageJ 1.43c / Java 1.6.0_14 (32-bit)
confocal-ser...
c:1/2 z:15/25; 19.80x17.64 μ (36
ge...
104x189 pixels; 8-bit (im
Plot of gel
200
100
Gray Value
0
50
100
150
Distance (pixels)
List
Save...
Copy...
t1-rend...
23/36; 206x218 pixels; 8-bit; 1
blobs.gif
152x134 pixels; 8-bit (inverti
Results
File Edit Font
Quantitative Analysis
Data
Sample
Base
Pivot
Explore
Transform
Combine

	Area	Circ.	AR	Round	S
1	681	0.885	1.332	0.751	0
2	465	0.903	1.183	0.846	0
3	533	0.916	1.188	0.842	0
4	435	0.908	1.446	0.692	0

We also realized that sometimes there are just pain in the ass logistical hurdles to faculty reform… like buying software, installing it on university computers, etc… so we are focusing on open source software tools that can be run remotely through our website… things like NetLogo and R and Rstudio and Shiny apps… so students can use the software in computer labs, their own computers, no hardware/software issues. Moreover, we can tailor the environments to be as user friendly as possible…

The reward problem:
Build a Teaching Scholarship Profile

Publish your work, contribute to projects, and track usage statistics and citations



Alison N Hale ▸ Usage

Table 1: Overview

Item	Value
Contributions:	20
Rank by Contributions:	2 / 30
First Contribution:	
Last Contribution:	18 May 2015
Citations on Contributions:	-

Table 2: Simulation Tool Usage

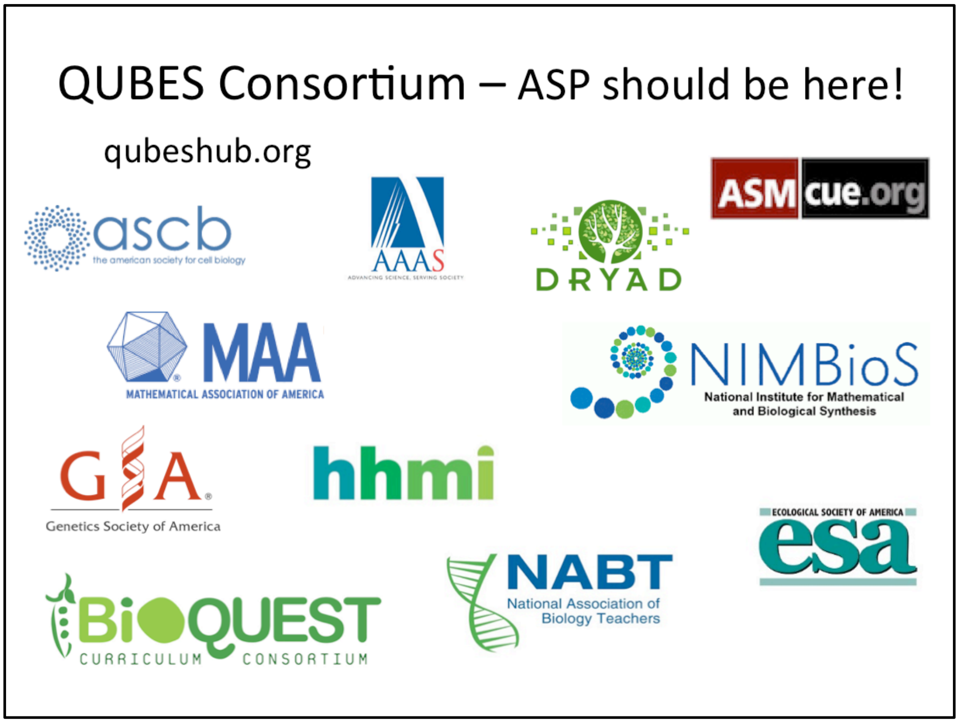
#	Tool Name	Users served in last 12 months	Simulation Runs in last 12 months	Total users served	Total Simulation Runs	Citations	Published On
No data found.							

Table 3: "and more" Usage

#	Resource Title	Users served in last	Total users served	Citations	Published On

Lastly, we have all this activity around teaching scholarship happening on the hub, and we can track it. Each person, resource, group has analytics being tracked about usage, number of clicks, amount of time spent using a tool…

So for instance I can automatically track how many people download my image analysis resources, record the reviews, and even see how many hours people are using ImageJ via the Hub…
This all can feed in to my NSF annual report for that project, and didn't cost me anything.

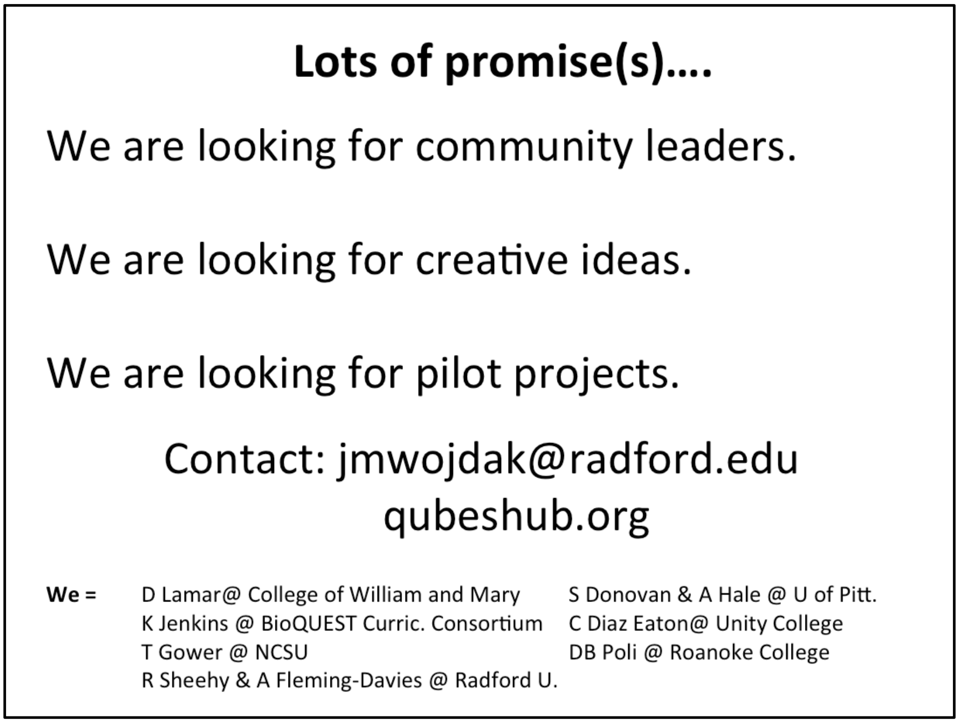


QUBES Consortium – ASP should be here!

qubeshub.org

ascb
the american society for cell biology
AAAS
ADVANCING SCIENCE, SERVING SOCIETY
DRYAD
ASM cue.org
MAA
MATHEMATICAL ASSOCIATION OF AMERICA
NIMBioS
National Institute for Mathematical and Biological Synthesis
GSA
Genetics Society of America
hhmi
ECOLOGICAL SOCIETY OF AMERICA
esa
NABT
National Association of Biology Teachers
BiOQUEST
CURRICULUM CONSORTIUM

We are looking for new partners, opportunities, collabroate on workshops and mentoring, etc. etc.



Lots of promise(s)….

We are looking for community leaders.

We are looking for creative ideas.

We are looking for pilot projects.

Contact: jmwojdak@radford.edu
qubeshub.org

We =
D Lamar@ College of William and Mary
K Jenkins @ BioQUEST Curric. Consortium
T Gower @ NCSU
R Sheehy & A Fleming-Davies @ Radford U.
S Donovan & A Hale @ U of Pitt.
C Diaz Eaton@ Unity College
DB Poli @ Roanoke College

But really nothing substantial is going to happen without the continued, dedicated effort of faculty that have been working on this problem for years, and the new faculty just joining. We haven't invented anything new, we are just hoping to make things easier and more efficient for the people doing the hard work. So if someone wants to teach an SIR model they don't have to build it from scratch, and struggle through how to teach it by themselves.