

Mid-point feedback/check-in

Please fill out a few post-it notes with:

Your excitement about teaching/using a module (**yellow**)

Your concerns about using/teaching a module (**pink**)

And then stick them on the poster board

So you want to teach a Macrosystems EDDIE module?

Lessons learned & tricks of the trade





Power, pitfalls, and potential for integrating computational literacy into undergraduate ecology courses

Kaitlin J. Farrell | Cayelan C. Carey

Department of Biological Sciences, Virginia Tech, Blacksburg, Virginia

Correspondence

Kaitlin J. Farrell, Department of Biological Sciences, Virginia Tech, 926 West Campus Drive, Blacksburg, VA, 24061.
Email: farrellk@vt.edu

Funding information

National Science Foundation (NSF), Grant/Award Number: EF 1702506, DEB 1245707, CNS 1737424 and ACI 1234983

Abstract

Environmental research requires understanding nonlinear ecological dynamics that interact across multiple spatial and temporal scales. The analysis of long-term and high-frequency sensor data combined with simulation modeling enables interpretation of complex ecological phenomena, and the computational skills needed to conduct these analyses are increasingly being integrated into graduate student training programs in ecology. Despite its importance, however, computational literacy—that is, the ability to harness the power of computer technologies to accomplish tasks—is rarely taught in undergraduate ecology classrooms, representing a major gap in training students to tackle complex environmental challenges. Through our experience developing undergraduate curricula in long-term and high-frequency data analysis and simulation modeling for two environmental science pedagogical initiatives, Project EDDIE (Environmental Data-Driven Inquiry and Exploration) and Macrosystems EDDIE, we have found that students often feel intimidated by compu-

Pitfall 1: Intimidation by computational tools

- Programming has a steep learning curve

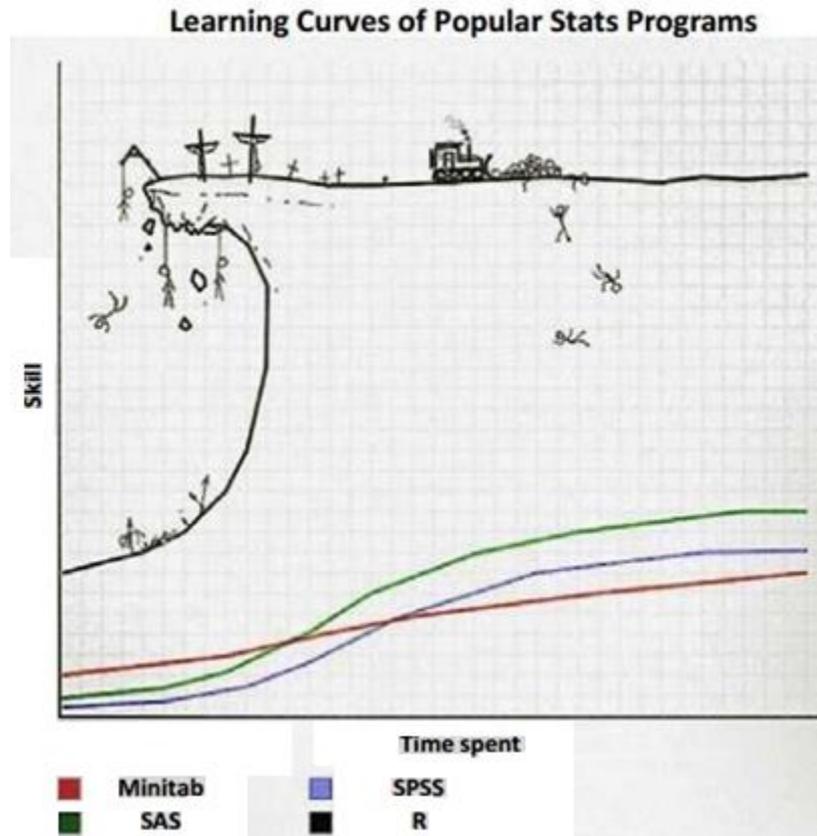
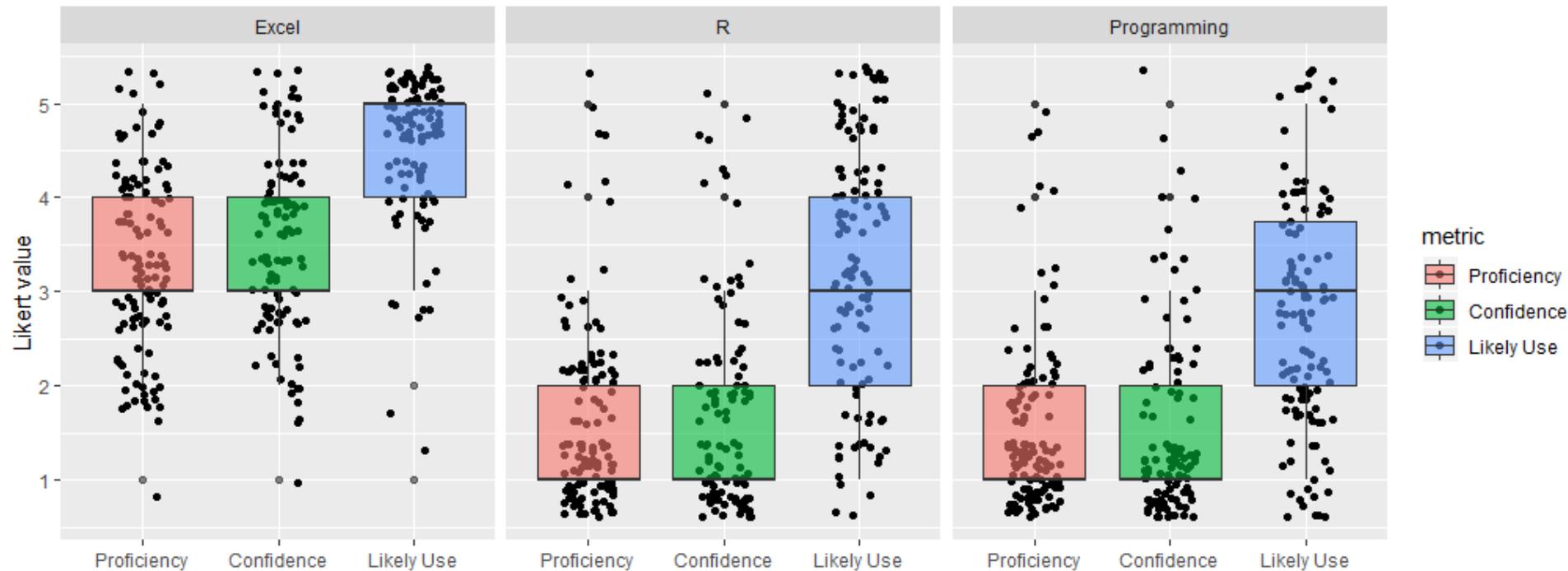


Image: https://norcalbiostat.github.io/MATH130/01_intro.html

Pitfall 1: Intimidation by computational tools

- Programming has a steep learning curve
- BUT many students recognize the importance of knowing how to program— they just need help getting started



Solutions:

- Module activities assume no prior knowledge of R or programming
 - Students modify and run ready-to-use scripts and models
 - Modules break down complex activities into short, do-able chunks of code to reinforce developing skills

```
# NOTE! Throughout the rest of the module, you will need to modify some of the  
# lines of code to run on your computer. If you need to modify a line, I put the  
# symbols ##!! at the beginning of that line's annotation.
```

- Use of real-world tasks makes programming relevant
 - *"I had very limited computer modeling experience prior to this activity. This was my first time truly modeling an ecosystem."*
- Patience and understanding is really important – the risk of failure seems very high

Faculty tester feedback:

"The module was really useful in engaging the students in an exercise using R without overwhelming them with details about how to actually write code. I think this was really helpful for the students who have never used R before to still feel like they were able to participate in the class exercise."

"I think that it is cool to introduce R to students in this way. It is much less intimidating than a completely blank slate and also gives students a taste for what is possible in R and any programming language."

Pitfall 2: "Digital natives"?

- Despite ready access to technology tools, students' individual computing experiences vary dramatically



Image via: <https://www.comaround.com>

- *"[my students] had essentially no coding (or, in some cases, computer) experience before attempting the module"*

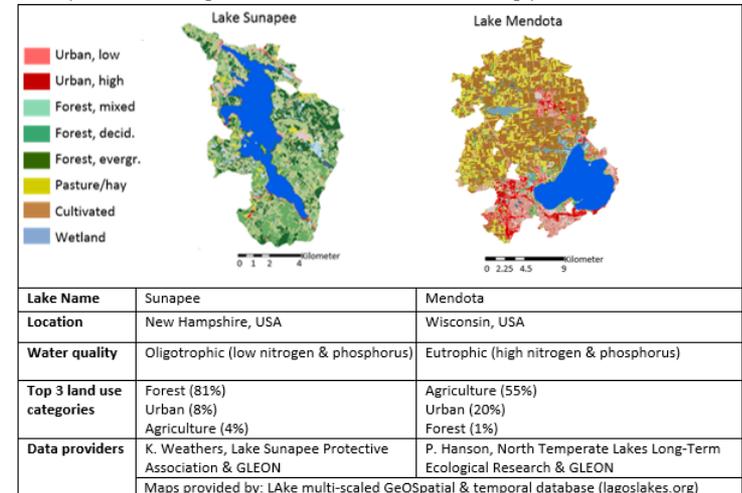
Solutions:

- Work with a partner to equalize experience levels
- Near-peer helpers → students who finish a section early can help fellow classmates
- Use worksheets and discussion questions to check-in and keep students engaged with the module materials

Name: _____

Think about it!

With a partner, read through the table below, and answer the following questions:



- 1) Which lake most likely *already* exhibits phytoplankton blooms? Why?
- 2) Which lake's water quality is likely to be more sensitive to climate change: i.e., which lake is likely to exhibit a greater increase in phytoplankton blooms with warmer air temperatures? Why?
- 3) Which lake's water quality is likely to be more sensitive to increased phosphorus loading due to land use change? Why?
- 4) If both lakes experience both climate change and land use change simultaneously, which lake is likely to exhibit a greater increase in phytoplankton? Why?

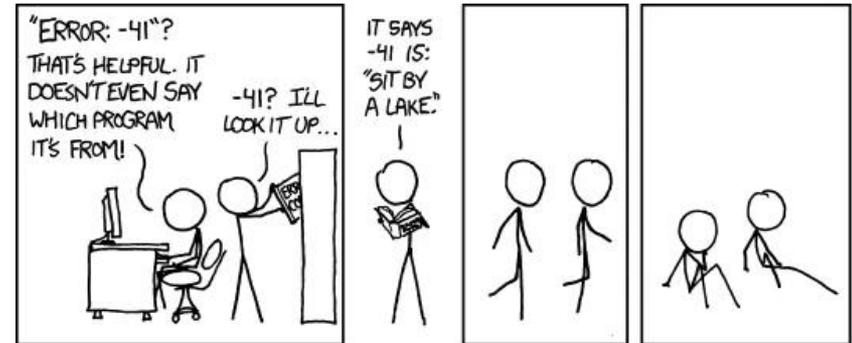
Student & faculty feedback:

"I enjoyed getting to fill in the worksheet along with using R so that way we had to understand the material, and not just plug in the code."

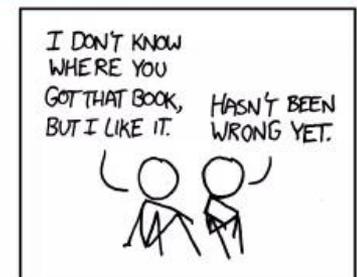
"My students had almost no experience with R or Excel but I am comfortable with both, so I was able to facilitate their use. The modules were very thoroughly prepared and with my experience as a regular R user, I was able to follow the workflow easily."

Pitfall 3: Trouble with troubleshooting

- Many students lack experience troubleshooting software issues
- "App-ification" of day-to-day computing tools tends to hide error messages and underlying source code

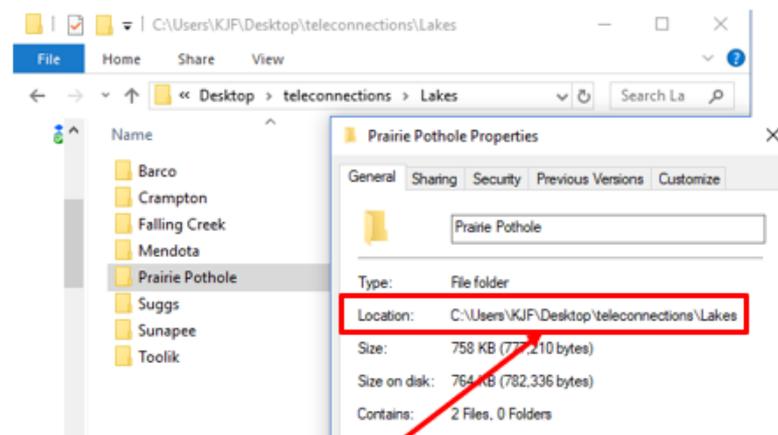


<https://xkcd.com/1024/>



Solution:

- Detailed step-by-step troubleshooting, with screenshots from Windows and Mac operating systems, help students resolve problems on their own
- Use of an on-campus computer lab can streamline troubleshooting, as instructors only have to juggle one type of operating system and version of R/Rstudio



In the R script, make sure you use the / dash, not \ (which is what Windows will show you!)

Error: Day 2451636 (2000-04-01) not found

When does it happen?

- `run_glm(sim_folder, verbose=TRUE)` will start the GLM run, but you will likely get an error similar to: "Day 2451636 (2000-04-01) not found"

Why?

- `time` column in `.csv` file not formatted correctly for GLM

How to fix it:

- 1) Open `.csv` file in Excel. Right click on the `time` column, then select Format.

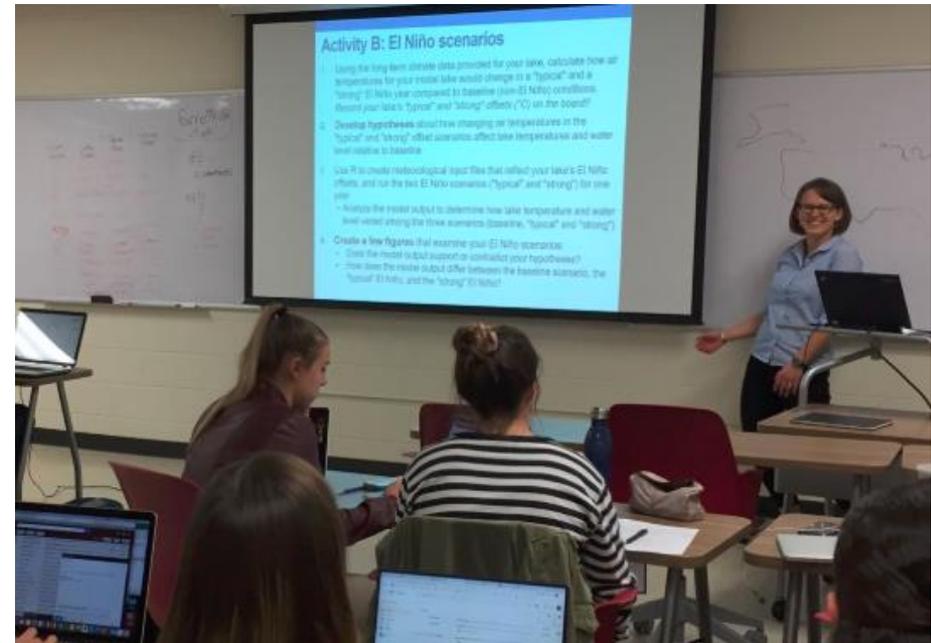
Faculty tester feedback:

“Students were able to follow the instructions in the R script and complete the module. We used a computer lab with R and RStudio preloaded which helped facilitate using the module.”

“One group crashed the module towards the end... but we didn't have time to solve the issue. This type of thing is bound to happen and is awesome that it only happened to one pair! In the future, I'll have clean files on a flash drive to quickly replace.”

Pitfall 4: Are you also intimidated?

- Instructors may lack experience and comfort with advanced computational tools, like R
- Hard to troubleshoot if you don't know what you're doing!



Solution:

- Prepared assuming no prior faculty experience with GLM model, very limited exposure to R
 - Recommend faculty do a full run-through of module on their own so they know what students will encounter!
- Complete modules are ready-to-use 'as is' or modified by faculty
 - Pre-packaged lesson plan for instructors
 - Pre-class readings
 - In-class activities & datasets
 - Homework & answers
- Testing with faculty from range of institutions and experience levels
 - Catch areas that need more detailed explanations

Discussion: Excitement & Concerns



Next steps for EDDIE: More modules coming soon!

Macro-Scale Feedbacks

- How do local and regional processes amplify each other?
- Model carbon source/sink dynamics for different GLEON and NEON lakes using GLM



Macrosystems Synthesis

- How do cross-scale interactions, feedbacks, and teleconnections affect water temperatures globally?
- Analyze drivers of GLEON lakes' water temperature using historical time series data





EDDIE: Earth Systems

Upcoming activities:

- Webinars (3):
 - Jan-Feb, about teaching with large datasets and how to use existing modules
- Workshops
 - June – Teaching with large datasets: barriers and solutions.
 - October – Designing your own classroom activities that use large datasets
 - Talk to Catherine O'Reilly this week to learn more!

projecteddiedie.org

Stay informed! Get periodic email updates by signing up.

Get Involved

Learn about webinars, workshops, opportunities, new teaching materials, and more. Sign up here to join the broad EDDIE community and receive email updates from the EDDIE program about opportunities, webinars, workshops, teaching modules, and news.

Name

Email

Submit



Ready for Macrosystems EDDIE?

Join us!

- We are seeking new faculty testers for Spring 2019 and beyond for Teleconnections and Cross-Scale Interactions
 - Want to try a module with your class and/or lab group?
We would love to include you!
- Do you have a GLM-AED model calibrated for your lake? Would you be comfortable with us including it in the Macrosystems EDDIE modules? Let us know!



WE WANT YOU