Welcome to the 2019-2020 Project EDDIE Webinar Series.

As you enter, please take a moment to review the Zoom controls below. Leave your audio off, unless prompted by a host. You can post questions in the chat box. Thank you!

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Project EDDIE is supported by funding from NSF (Earth and Ecosystems IUSE Award 1821567; Environmental Data DEB Award: 1245707; and Macrosystems EF Award: 1702506) and ACI (Award: 1234983)
Welcome to the 2019-2020 Project EDDIE Webinar Series

Free and open to the public, this series brings together a community of faculty instructors interested in teaching quantitative reasoning and using large datasets. The series aims to build a community-sourced assessment of effective ways to teach using large datasets, and to discuss the development and implementation of Project EDDIE pedagogical tools and teaching modules in the classroom.

About Project EDDIE Earth and Ecosystems – [https://serc.carleton.edu/eddie/earthecosystems/about.html](https://serc.carleton.edu/eddie/earthecosystems/about.html)

Upcoming Opportunities

**How to Adapt EDDIE Modules to Meet Students' Needs**
Thursday, February 14, 2019 10 PST | 12 CST | 1 EST
Presented by: Jen Klug
https://serc.carleton.edu/215841

**Using Time Series Data in the Classroom**
Wednesday, March 6, 2019 9 PST | 1 CST | 2 EST
Presented by: Dax Soule and Glenn Kroeger
https://serc.carleton.edu/216981

**EDDIE Modules for Macrosystems**
May 2019 – More information coming soon!
https://serc.carleton.edu/185621

**Workshop: Teaching with Large Data Sets**
June 11-13, 2019
Carleton College, Northfield, MN
Applications will be available later in February
https://serc.carleton.edu/216011

**Workshop: EDDIE Teaching Module Design and Development**
October 2019 – Details coming this spring

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News Page - https://serc.carleton.edu/215652
Community Email list – https://serc.carleton.edu/214401
Developing students' quantitative reasoning skills using large authentic datasets and Project EDDIE modules

Catherine O’Reilly and Rebekka Darner
Illinois State University
Goals of today’s talk

1. Understand the role of quantitative reasoning in science
2. Recognize how students' misconceptions persist despite direct instruction
3. Appreciate how working with large datasets can improve quantitative reasoning as well as force students to address their misconceptions
Three areas of quantitative learning:

- skills
- literacy
- reasoning
A common type of QR: Proportional reasoning - the deliberate use of multiplicative relationships to compare quantities and to predict what the value of one quantity should be based on the values of another.

(Lamon, 1999)
What are misconceptions you commonly encounter as an instructor?
How learning happens: A constructivist perspective

• Creating memories/learning always begins with experience.
• Creation of memories/learning is creation of new connections between concepts.
• Memories/learned material is stored in the brain as schemata.
How learning happens: A psychological perspective

• New knowledge is built off of pre-existing schemata.
• Schemata set up our expectations of all experience.
• Schemata change only when an experience elicits cognitive conflict.
A first experience
More experiences...

... so that eventually the concept is abstracted:

Plants are green organisms that need water and grow in soil.
Then the learner, with their plant scheme, encounters these:
How do you deal with misconceptions as an instructor?
Misconceptions

- Make sense from the learner’s perspective, given their experience
- Can only be “fixed” by providing the learner with an experience that conflicts with their scheme
- Hence, the power of working with large datasets
Why do students have misconceptions about climate change?
1. Is the average global temperature of Earth increasing?
2. Is atmospheric CO\textsubscript{2} increasing?
3. Is temperature related to atmospheric CO\textsubscript{2}?
4. How do current changes in average global temperature compare to pre-historic changes in these variables? What does this suggest about whether recent changes in temperature are due to natural or anthropogenic (human) factors?
EDDIE Climate Change module: A walk-through

Students use temperature and CO$_2$ datasets to explore climate change

Current temperature change

\[ y = 0.0066x + 1.1197 \]
\[ R^2 = 0.7662 \]
EDDIE Climate Change module: A walk-through

Students use current temperature and CO$_2$ records to explore modern rates of change

Current temperature change

\[
y = 0.0066x + 1.1197
\]

$R^2 = 0.7662$

Rate = 0.006 C per year
EDDIE Climate Change module: A walk-through

• Students use ice core temperature and CO2 records to explore pre-industrial rates of change.
EDDIE Climate Change module: A walk-through

• Students chose what data to use to calculate a pre-anthropogenic rate of change

Glacial-interglacial period temperature change

What’s the fastest 'natural' rate of warming?

0.0012 C per 1000 years

\[ Y = -0.0012x + 104.18 \]
EDDIE Climate Change module: A walk-through

• Students chose what data to use to calculate a pre-anthropogenic rate of change

Glacial-interglacial period temperature change

What’s the fastest 'natural' rate of warming?

0.0012 C per 1000 years

compared to

Modern rates of change;

0.006 C per year

OR

0.6 C per 1000 years
1. Is the average global temperature of Earth increasing?
   • Yes, there is a positive slope.

2. Is atmospheric \( \text{CO}_2 \) increasing?
   • Yes, there is a positive slope.

3. Is temperature related to atmospheric \( \text{CO}_2 \)?
   • Yes, the r-squared statistic indicates a substantial amount of the variation in temperature is explained by atmospheric \( \text{CO}_2 \).

4. How do current changes in average global temperature compare to pre-historic changes in these variables? What does this suggest about whether recent changes in temperature are due to natural or anthropogenic (human) factors?
   • Current rates of increase are \(~100\) times the fastest rates of increase observed, suggesting recent changes are anthropogenic.
A note of caution when confronting misconceptions

- The backfire effect is real.
- Remind students that an accurate conclusion is the goal.
- Don’t attack the identities of those making the false claims
  - Students relate to these people.
- Emphasize core facts, not necessarily all the facts.
- Explicitly state that false information is false.
Why working with large datasets addresses misconceptions and improves QR

- Hold the potential to elicit cognitive dissonance
- Opportunity to practice quantitative skills
- Compels students to make analysis decisions, thereby giving meaning to analytical procedures
• Project EDDIE has a set of modules that all incorporate these concepts.

• We're working to help faculty implement them and develop their own modules

Questions?
Thank you for attending!

Project EDDIE Webinar Series

We appreciate your feedback and ideas

Webinar assessment: https://serc.carleton.edu/217453
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