OCESE Professional Development Workshop 2

Dashboards: Making Concepts interactive

Open-source computing
for Earth Sciences Education

Session outline *(Present for 20-25 mins. then discuss for ~30 mins.)*

1. (5) **Making concepts interactive**
    1. Precedent
    2. Current OCESE model.
2. (10) **Initial examples** from ENVR 300
3. (10) **Pedagogy** with dashboards: components, students' tasks, worksheets, feedback
4. (30) **Brainstorm and discuss** courses, topics, objectives, steps.
5. (5) **Making dashboards**: development steps.

(~60 total).

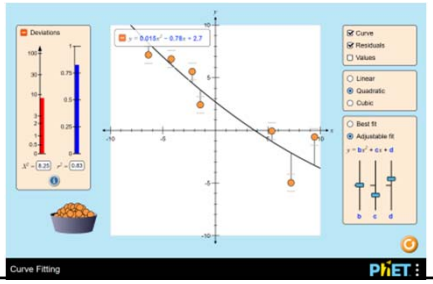
These notes are at https://drive.google.com/file/d/1JWsjSL8JDrAnCqxIu5cEhSmkMMAdv3HH/view?usp=sharing

1

1. Why make concepts interactive?

- Illuminate challenging concepts – examples …
    - EM fields
    - Curve fitting for data sets with uncertainty
    - Inversion, optimization, machine learning,
    - …
- Let students "play" with concepts
    - Explore cause & effect
    - Try and "fail" safely
- Facilitate "argument" or "discussion" about concepts.

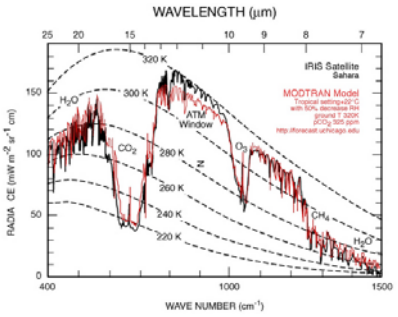
https://phet.colorado.edu/en/simulation/curve-fitting



2

Alternatives already out there

- It pays to carry out some due diligence
- Examples:
  - **Earthviewer** at https://www.biointeractive.org/classroom-resources/earthviewer
  - Carrying capacity and logistic model for population growth here.
  - Greenhouse effect / glacier behavior / radioactive dating / gravity & orbits … a total of 25 Earth Science PhETs.
  - Interactive **data sets** at **NOAA**
  - Climate and Carbon Cycle Models online.
  - Etc.
- Leverage what's out there … but adapt or build new and local resources as needed, with accompanying "how to teach".



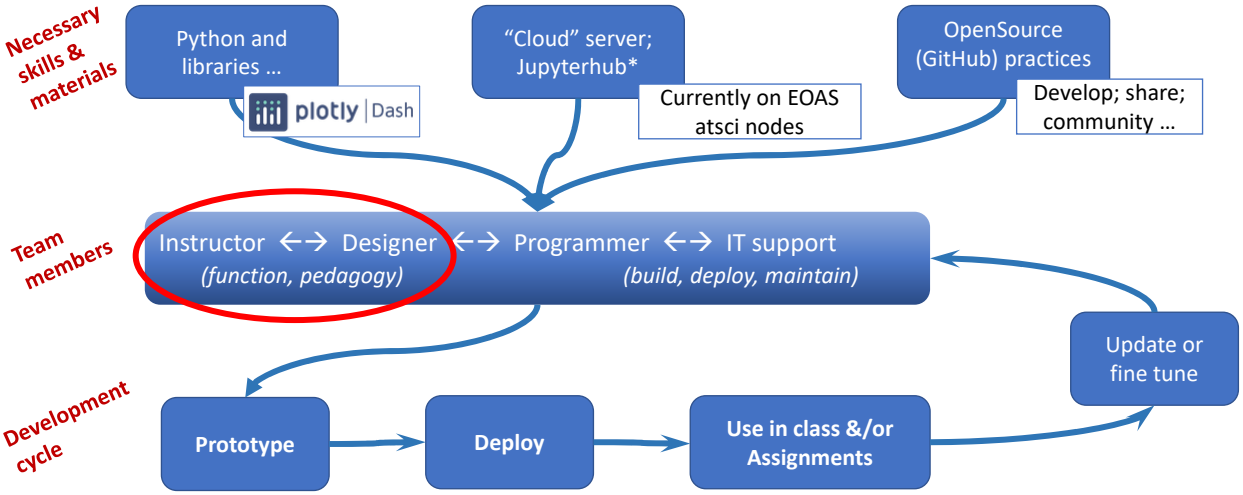
3

How are we in EOAS making our own?

- Identify the need and potential – that's today ☺
- Explore precedent before committing to design/build
- Then
  - Build,
  - Test,
  - Deploy,
  - Refine based on experience and feedback
  - Maintain …

4

OCESE model for making & deploying dashboards



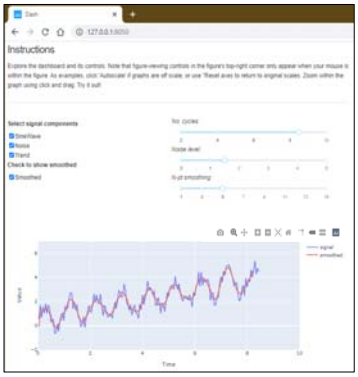
* JupyterHub is a way to serve Jupyter notebook for multiple users.
It spawns & manages multiple instances of a single-user Jupyter notebook server.

5

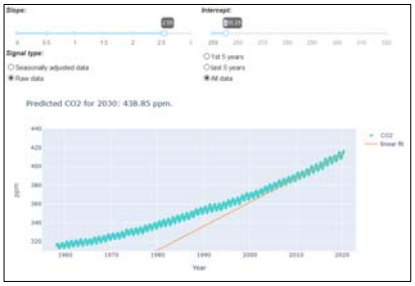
2. Initial examples for ENVR 300

Three types: explore ◆*concepts* ◆*models* ◆*data*

Concept: Signals on noise



Models: linear approx'ns.



Data: 1-year Ozone at two locations

6

Aspects to consider

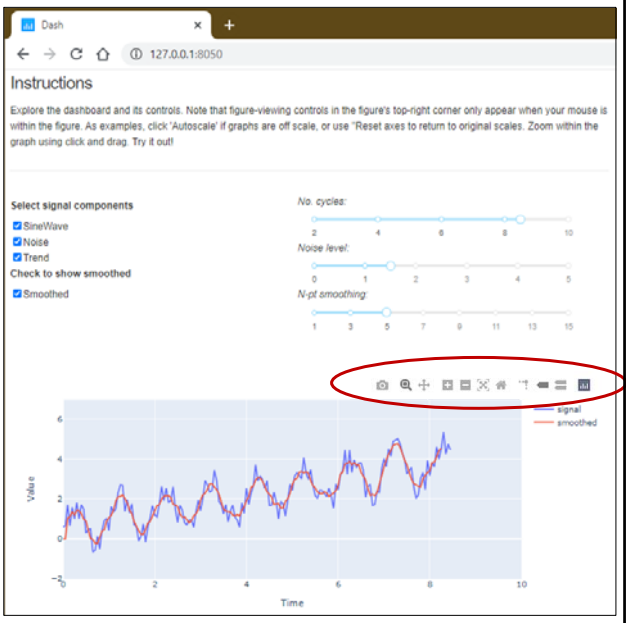
1. The “challenge” – what do students need to “play” with?
2. Data set, equation or model
3. Visualization
4. Ways to explore
5. Learning tasks
6. What students “deliver”

7

Example Dashboards

1) Interactively explore a concept

- Signal components:
  - Signal | Noise | Trend
- Implications for measurement and interpretation.
- Impact / limits of smoothing.
- Questions to guide thinking.



https://hub.envr300.portal.eoas.ubc.ca/services/external/envr-300/three-signals/

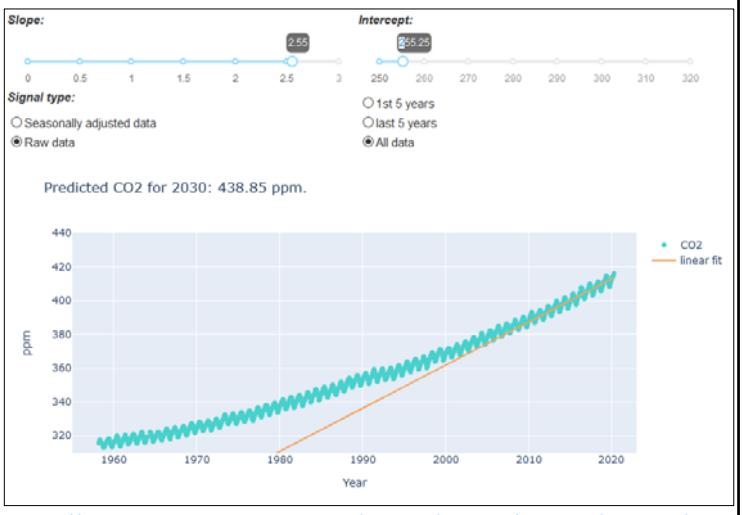
8

Example Dashboards

2) Explore modelling

- CO2 at MaunaLoa
- Linear fit to segments.
- Compare predictions.
- Judge applicability and limitations.

- Guiding questions



https://hub.envr300.portal.eoas.ubc.ca/services/external/envr-300/monaloa/

9

Example Dashboards

Tested but not yet used by students

3) Explore datasets

- One year of hourly Ozone at 2 stns.
- Compare YVR and Abbotsford:
  - Where/when are levels elevated? Why?
- Compare "averaging" options
  - Daily mean.
  - Maximum daily 8hr average.
- Compare lines, markers or both.
- Questions to guide thinking.

https://hub.envr300.portal.eoas.ubc.ca/services/external/envr-300/ozone/

10

3. How can we use these?

Options:

- Demonstrate in class.
- Solo short in-class activity with rapid followup (eg clickers)
- Group in-class activity:
  - Worksheets
  - Clickers
  - Online, shared worksheets
- Assignment (solo or group)

Ideas limited only by imagination

11

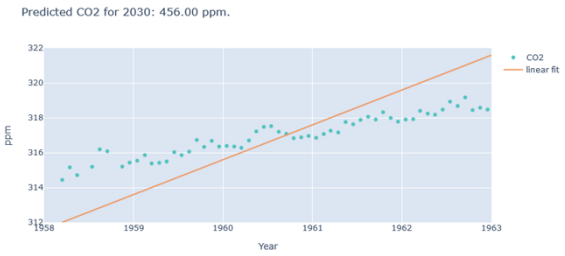
Dashboards – what to include with the app?

1. Purpose
2. Define terms
3. Instructions
4. Interactive controls
5. Graphics
6. Questions to consider (assignment); same as worksheet for delivery
   - Low level – to familiarize
   - Higher level – "analyze, evaluate, create" (use **verbs** such as these).
   - Capture images demonstrating work or results.

12

Students' tasks

Mauna Loa CO_2



Within relatively short time windows (e.g. 5 years), the linear model can represent a reasonable fit to the data, but it remains less clear how good the predictive power of this model is for longer periods.

To analyze this further, revisit the linear fit for "early" and "recent" 5 year periods and **answer the following**:

1. **Out to which year would you trust** the model built for the window 1958 - 1963? In other words, where does this model start to break down?
2. **How far out would you trust** the model predictions with the model built for 2015 - 2020? Would you trust the model to predict CO_2 for the year 2050?
3. **How might you approach building** a model to fit all of the data (1958-2020)?
4. Given what the "raw data" look like, **what do you think "seasonally adjusted data" means**?
5. Use the graph's "Camera" icon to **make a PNG file** with all data and linear model fitting determined from the *first* 5 years.
6. Do the **same for the case** with linear model fitting from the *last* 5 years. **Submit both PNG files** for assessment.
7. FINALLY – please individually complete the online anonymous **feedback form**.

13

Online teaching: what can students deliver?

- Google Sheets / **Docs** / Slides — *(great for "instant" feedback and discussion)*
- Google **forms** — *(when sharing is NOT desired, & to ease collecting)*
- Canvas quiz — *("essay" qns include rich-text & media)*
- Qualtrics form or quiz — *(fancier questions, sequencing logic, etc.)*

Instructor's experiences:

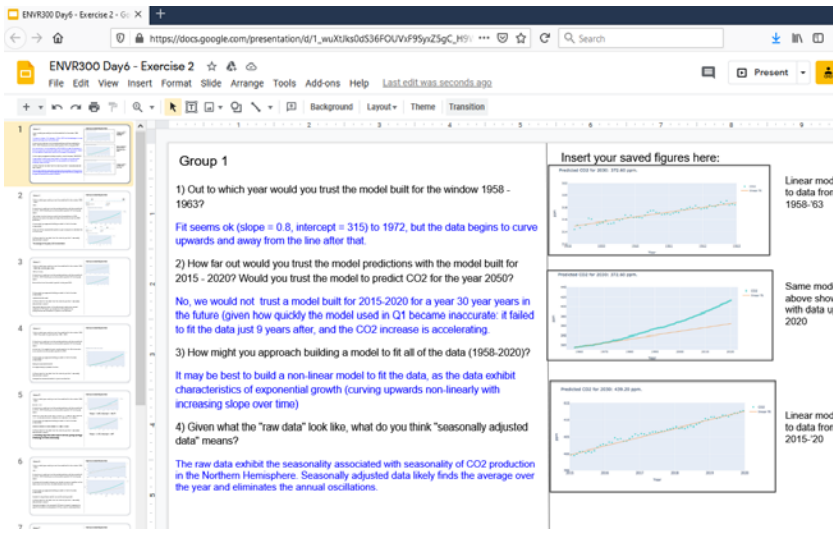
- *" shared google doc/sheet/slides is working so well for the group activities …"*
- *" I recommend keeping even when … in person."*
- *" In class, I can display shared docs on screen and ask students to comment"*
- *" Much, much better than asking students to write on a piece of paper"*

14

Online worksheets; example using "Slides"

Includes:

- 1 slide per group
- Questions in black *(as per dashboard)*
- Student answers in blue
- Images added using Dash "clip-to-png".
- Instantly able to review group work in class.

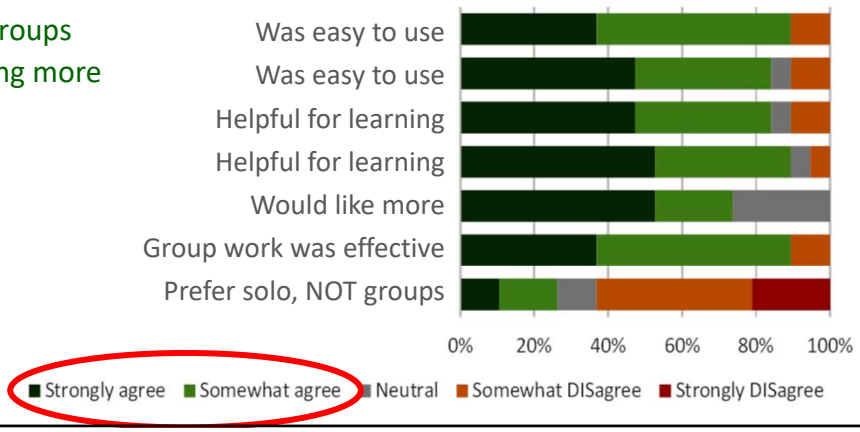


15

Student feedback: N=19, 34% of 56 studnets

~ 80% of respondents found dashboards

- easy to use,
- useful,
- prefer doing them in groups
- would appreciate seeing more



16

Student feedback from "three-signals"

What did you like?

- *"Nice to interactively visualize how graphs change in real time"*
- *"Able to play with the slopes etc. rather than just an image on a powerpoint"*
- *"Able to learn both individually and in a group simultaneously"*
- *"Easy to use and provided interesting insights into Mauna Loa CO2 levels."*

17

Student feedback from "three-signals"

Suggestions:

- "More formal introduction to the data and its questions would be nice."
- "I was really confused when looking at the terminology."
- "would be helpful to fiddle with the activity individually first (so there's not a lot of silence in the breakout rooms) and then discuss answers with other group members."
- "sliding bar was hard to use because the range was so large, but in general it was OK."
- "have additional or more complicated questions."
- "introduce the tasks and wait for questions before sending us into breakout rooms."

18

Any questions so far?

19

4. Discussion time: demonstrate online “worksheets”.

Goals

- Where / how might dashboards improve student learning or your teaching experience?
- Share to generate inspiration
- Identify priorities for OCESE dashboard development.

For the rest of today:

- Questions for participants to address solo (use a Google Form)
- Then, meet in groups & use a Google Doc to gather discussion points.
- Return from groups to share / discuss
- Wrap up

20

Questions to address solo (~5 mins)

Submit only AFTER your discussions

Google form: https://forms.gle/DN5n8ttZC5y86zJT8

1. Have you used interactive models, datasets, etc. in any of your teaching activities recently? If so
   a) what course; (b) what concept; (c) what resource?
2. Which course or courses are you thinking of as we discuss support from the OCESE project?
3. Briefly, what are one or two data / math / physics (etc.) concepts that student struggle with, or that are "awkward" to teach?
4. When can you anticipate wanting to introduce these ideas?
   Sept 2021 Jan 2022 Sept 2022 Jan 2023 other?

21

Gather in groups (~15 mins)

Google Docs:

1. Our goal is NOT to design everyone's idea today …
2. Instead, we will discuss one in each group - you choose.
3. We want to practice the first DESIGN phase for developing these resources.

Group Docs

1. Moved to trash
2. Moved to trash
3. https://docs.google.com/document/d/1yRUT7nVlH_Jii97voNbFEBWbH8v6uHELUnqRnemqcwM/edit?usp=sharing

You should all be able to see the doc you are working on together in your groups. (Not possible with "forms".)

22

Group discussion questions

1. What is the conceptual or teaching challenge being addressed by your chosen topic?
2. What data set, equation or model, etc. is relevant? *(Keep it simple / succinct at this stage - we can get more ambitious later!)*
3. What visualization(s) would be appropriate to help students work with the ideas?
4. In what ways might students explore the data, ideas or concepts?
5. How might this translate into tasks for students to complete?
6. ***If time permits:***
   What would students "submit" or "deliver"? Or maybe no deliverable is needed?
7. ***If time permits:***
   Might these be for demonstration only? For in-class activities? An assignment? Optional?

23

Return from groups (~10 mins)

Discussion with everyone

1. Share the challenge, task, interactivity and visualization.
2. Discuss questions, concerns, suggestions.

Next steps – discuss timelines.

Wrap up

24

5. Making dashboards

Who's involved?

- Teacher (maybe TAs & students)
- Developer
- IT support

What are the steps

- Design: Data, equations, visualizations WITHIN an E., O., or A. science context.
- Develop: Python, using specific graphing and interaction libraries.
- Test: 3rd parties, TAs, students
- Deploy: Cloud servers; apps to be reliable on all platforms.
- Maintain: Versioning, sharing (opensource), transferring ownership, etc.

25

Dashboard development steps

	Steps	teacher	developer	IT support
1	**Purpose** and student's / instructor's **tasks**			
2	**Collect** / prepare data, equations, etc.			
3	**Prototype** code & plots (Jupyter notebooks, Python, …)			
4	**Parameters** to adjust? What resulting behaviors?			
5	Convert to "**app.py**" – just python, and test locally.			
6	**Layout:** design, code, test the appearance of the app.			
7	**Callbacks:** design behavior one parameter at a time.			
8	**Instructions**, pedagogy and tasks (e.g. question set)			
9	**Repositories**: GitHub, for both development & deployment			
10	**Beta-test** with third parties & refine			
11	**Server** setup			
12	**Containers** and packaging specifications.			
13	**Deploy** to server and set up **GitHub automation**			
14	**User-test,** gather feedback, fine tune …			

26

OCESE timeline as of Feb 2021, but it is evolving

Some changes since September due to evolving faculty commitments

Possible priorities?

	UPDATED January 2021		2020		2021			2022			2023	
	Course		Sum	Win T1	Win T2	Sum	Win T1	Win T2	Sum	Win T1	Win T2	Sum	Win T1
1	EOSC 211	Transformation	D	T		D		T2	July '22: PA goes 1/2 time?				
2	ATSC 301	Transformation	D	T									
3	ENVR 300	Dashboards	P	D	T		D	T2					
4	ENVR 420	Transformation			P	P	D	D	T				
5	DSCI 100	Development			P	D	D?	T?			T?		
6	EOSC 340	Dashboards			D	D	T						
7	VANT 110	Dashboard	Maybe		P	D	T						
8	EOSC 442	Transformation	accelerate? Ask Lipsen					P	D	T			T
9	EOSC 372	Dashboards	accelerate?		P	D	T						
10	EOSC 373	Dashboard	accelerate?			P	D	T					
11	EOSC 325	Dashboards?	Ali will build/teach			P	D	T					
12	EOSC 329	Dashboards	Uli teaches as usual				P	D		T			
13	EOSC 471	Transformation	after 372/373					P	D	T			T
14	EOSC 410	Transformation	unclear; VR away for 12+ mths starting Su					D?					
15	EOSC 354	Transformation	on leave, Jul 2021					P	D	T			
16	EOSC 429	Transformation	delay; Roger going on leave.							P	D		T
17	EOSC 350	Dashb? Xform?	unclear if this is part of OCESE; ask Lindsay when she arrive							P	D	D	T

27

Meeting summary

- Enable students to *explore*, *query*, *test* ideas, *argue*/discuss …
  - **Instructors**: Easily add to lessons or assignments.
  - **Students**: Easy to use: "near zero" learning curve, active, inquiry-oriented
  - Online, in class, or as homework.
- Next steps . . .
  - Have you got ideas? Discuss with: Francis / Phil / Tara
  - Summer 2021 workshops: (i) dashboard "management" (ii) pedagogy
  - Summer 2022: standard procedures should be in place
  - (Summer 2022 workshops: Jupyter notebooks – building and teaching with.)

28