Future-ready computing & quantitative skills; opensource solutions in Earth Science courses

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Project goals
- Introduce opensource computing facilities to enhance quantitative & computing learning in EOSC, ENVR, ATSC courses;
- Establish sustainable local & institutional infrastructure & workflows;
- Support faculty to transition courses or course components.

Openesource computing facilities we are working on
- Jupyter notebooks, including auto-grading, question management, and other plugins;
- Open & interactive textbooks and related resources (e.g., Jupyter Books);
- Question and assessment tactics;
- Interactive dashboards to explore Quantitative Earth Science concepts & data sets;
- Hubs and cloud-computing processes and workflows;
- Collaborative development steps with colleagues in UBC & beyond.

Open Education Resources (OER) being produced

OER Interactive learning resources
- Jupyter Notebooks now in: EOSC211, EOSC213, EOSC354, ATSC301, more soon;
- Interactive dashboard apps: 12 built. 10 piloted in 7 courses.

Some examples:

Oceanography
Hydrogeology
"Depositional" & "Atmospheric CO2"
Climate factors

OERE Content
- Jupyter Books written for, or adapted from, open source:
  > Courses: e211, a301, a409 >start-up & sftwr guidelines, >Programming.
  > Project documentation contents See https://eoas-ubc.github.io/index.html
  > Question sets and question management tactics (see below).

Assessments
- Randomizing questions, especially with PrairieLearn;
- Autograding and management using nbgrader (in Jupyter notebooks);
- Interfacing Jupyter, nbgrader, Markdown, Canvas/PrairieLearn.

Python replacing Matlab or R
- In eosc211, 354, 410, 422, 429, envr420.
- Also, a new Python section for DSCI 100.

OERE Documentation

Project & Outcomes
- Jupyter and contributions
- Jupyter and contributions
- Jupyter enhancements to [22] programming.
- Jupyter dashboards
- Jupyter Notebooks
- OERE Project evaluation
- How-to Guides
  - Jupyter guidelines
  - Jupyter dashboards
  - Jupyter Notebooks
  - Python software
  - Command line & Shells
  - Command line & Shells
  - Git and Git versioning
  - Git and Git versioning
  - Git online resources
  - Git online resources
  - GitHub
  - GitHub
  - GitHub
- Tutorials
  - Python
  - Python
  - Libraries & packages
  - Interactive dashboards
- Open Education Resources

Some reactions from students and instructors

Student feedback survey results (selected): Prior knowledge & resources survey for EOSC 211;
- Dashboard feedback examples (well received) →
- Other survey data: EOSC 112, 211, 354, 325;
- Qualtrics feedback for each (1 line of code).

NOTE: students always provide insightful recommendations after a pilot phase.

A few student quotes
- E112 dashboard feedback results: explains the effects of the contributing factors in a visual way and was straight to the point when explaining with words.
- And very organized and easy to use, simple and concise explanations and good visuals.

Suggestion: Maybe add more descriptions on which each contributing factor means and what does the sum selected factors actually do, especially for layperson.

E372 student feedback: I liked how the dashboard exercise applied various concepts using real data from the world’s oceans. The online dashboard was quite easy to use and interesting as it allowed us to compare different nutrients/properties profiles in different oceans, synthesizing all the concepts in the course.

E211 student feedback (highly selected):
- What was helpful? "workshets", "practice problems", "TAs are great", "peers", etc.
- What was challenging? "organization", "coding and understand the question", "the labs", etc.
- Recommendations: "more feedback", "explain code line-by-line", "focus in lectures", etc.

A few instructor quotes
- E372 Instructor feedback: I am so impressed … I love how (a) sliders constrain and adjust axes, (b) data at various real stations can be chosen on a map and compared, (c) results can be saved to submit for assessment. I agree that now is the time to finalize an assignment, so thank you to the team!
- Envr300 paraphrased: The in-class group activity that used the atmospheric CO2 dashboard worked very well. I will likely use the same procedure when we are in-person again.
- E325: email end of term: Thanks so much for detailed assessment. Students suggestions are very helpful and I will reflect on them in the rest of this term and certainly incorporate them in the course design next fall.

Class or lab observations (in person and online)
- 211: first week (copus) + winter install lab; notes & TA feedback on effectiveness.
- 354: support and feedback for an instructor (PhD student) new to teaching.
- 112: observations and feedback for a TA delivering a new climate modeling lesson with an activity using IPCC’s online Climate Atlas. https://interactive-atlas.ipcc.ch/

Contributors so far:

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Looking Ahead: final year expectations

- Python &/or Jupyter for 6 – 12 additional courses (some more ambitious than others)
- Dashboards: 4 – 10 more for topics in climate, geophysics, oceanography, & others
- Documentation: See https://eoas-ubc.github.io/index.html
  - project outcomes & evaluation,
  - how-to-guides & tutorials,
  - references & resources.
- Recommendations re: UBC computing infrastructure for undergraduate learning.
- Critical that UBC works within the opensource ecosystem (solo = unsustainable)
- Institutional community is active and growing (finally!) – needs fostering!
- TAs and instructors learn development techniques (GitHub, Jupyter, etc.)
- Yet – challenging when critical components go un-supported for a while (nbgrader).

More details:
- Github: https://github.com/EOAS-UBC/EOAS_Tlef
- Website: https://eoas-ubc.github.io/
- Summary: https://www.eoas.ubc.ca/education/current-major-initiatives/oecees