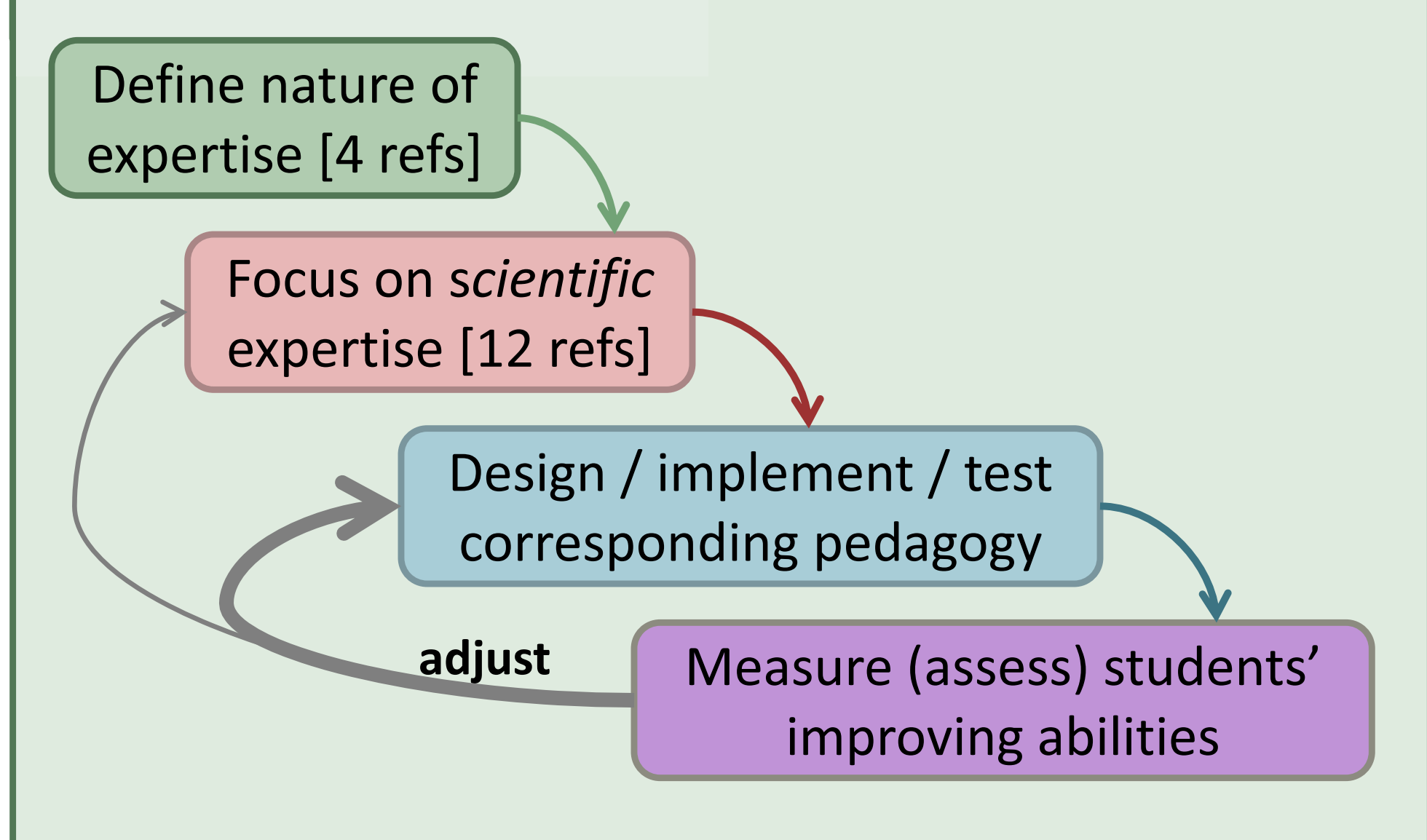


Project outline



The Course: EOSC212
Topics in Earth and planetary sciences
 13-week, 2nd year course designed to:
 • Foster generic scientific skills while exploring 3-4 Earth and planetary science topics.
 • Pedagogy and assessment based on experience and literature on expertise & science expertise.

Classroom practices:
 • team-based learning strategies,
 • replace exams with quizzes and projects,
 • mix team-teaching with solo-teaching,
 • discursive rather than didactic instruction,
 • use of diverse, Department-specific topics.

Assessment practices:
 • individual / team quizzes
 • weekly abstract writing
 • weekly assessed questioning
 • team-based data analysis exercises
 • pre-post testing of model based reasoning
 • Poster & presentations (students choose topics)
 • Peer assessment of posters & presentations

Data & results of using strategies (3 terms):
 • Abstract writing skills improved then plateaued.
 • Thinking with (& about) models/data improves.
 • Questions posed ...
 ○ depend on article type.
 ○ become more articulate.
 ○ become more insightful, less about content.
 • Surveys showed students appreciate
 ○ topics
 ○ team work
 ○ practicing communication & peer assessment
 ○ the discussion orientation

Continuing challenges:
 • Assessment of question type and quality
 • Use of question-posing as a measure of expertise

Conclusion: (Lessons Learned)
Improving science thinking expertise involves explicit guidance in aspects involving judgments and metacognition. For EOSC212 these are:
 • Synthesis of new knowledge (abstract writing);
 • Posing questions of various (& relevant) types;
 • Appropriate use of 'models' & 'data' in discussion;
 • Communication (written, oral and poster);
 • Assessment of peers' work & thinking.

Experts Have ...

- Concept (content) knowledge [2][6][14]
- Strategic knowledge [2][6][14]
- Procedural knowledge [1]
- Frameworking (uses schemas) [2][6]
 - Flexible retrieval
 - Noticing patterns
 - Integrate new info. into schema
 - Adaptable (transfer)
- Metacognitive habits [2][6]
 - Learning is "deliberate"
 - Actions are planned & monitored
 - Making judgments is multifaceted
- Affective characteristics: [1]
 - Beliefs: relevance / irrelevance
 - Motivated to apply expertise
 - Expectations of what's achievable
- Pedagogic domain knowledge [2]

Expert Scientists ...

- Have significant domain knowledge [2][6][12]
- Use analogic thinking [5]
- Use distributed reasoning (team player) [5]
- Identify & follow up anomalies [5]
- Frequently questions work & assumptions and generates hypotheses [4][7][10][11]
- Can design & execute experiments [14]
- Are measurement and/or observation oriented [3][14]
- Evaluate relevance & quality of data [12][14]
- Fluently use and relate models & data (including math and others) [4][8]
- Can articulate explanations & syntheses [12]
- Use evidence & rhetoric in argumentation [12]
- Use graphical representations both for making sense and arguing. [2][12][9]

Readers ... Did we forget any aspects of "scientific expertise"?

Use *post-its* to contribute below.

References on attached handout, & via
<http://www.eos.ubc.ca/research/cwsei/scientificskills.html>

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 • This project is generously supported by the *UBC Carl Wieman Science Education Initiative (CWSEI)*
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EOSC212: Topics in Earth & Planetary Sciences

- Features of this course:**
- 2-3 readings per module
 - Solid Earth physics
 - Planetary science
 - Atmospheric/oceanography
 - Individual and team quizzes
 - Model based reasoning Pre-Post
 - Abstracts / questioning workshops
 - Abstracts written for each article
 - Questions posed for each article
 - Team exercises with data & models
 - Discussion oriented lectures lead by
 - Dual instructors
 - Single instructors
 - Guests
 - Student - chosen projects
 - Oral presentation
 - Poster presentation
 - Peer assessments

Data demonstrating learning

Writing abstracts for science articles

- Workshop in week 2 → rubric for abstracts.
- Write abstracts for 1-2 SciAm or Nature articles per wk.

Reasoning with models and data

- Pre-test: based on article #1 - 6 questions about models & data.
- Post-test: Students reminded to re-read article. Same questions. Done in last week of class.
- Ability to discuss data & models matured.

Quizzes on readings: Individual & Teams

- Team-Based-Learning style (TBL) - Individuals ... then ... in teams.
- Team quizzing promotes: Instant feedback (IFAT cards) Peer discussion & instruction
- Monitor quiz metrics: Find and fix poor questions Identify misconceptions Compare teams & individuals

Question level

- "Low" level => background, basics, unqualified 'what if', etc.
- "High" level => relationships, assumptions, extensional thinking, etc.
- Fewer low's in 2009 - Better students? - Better pedagogy?
- Depends on article.

Feedback about presentations; self-selected topics & peer assessed

What YOU got out of it

Most frustrating

Advice to peers for next presen'n

Self-reported hrs. to complete not correlated with result

Grading: peers vs. instructors

Question type: Discussion vs Content

Does **type** of question posed depend on **article** or **year**?

- More discussion questions in 2009.
- ~10% of questions are "non-science".
- **Hurric vs Climate:** Depends more on **article**.
- **Mars vs Venus:** Depends more on **year**.

Therefore ... in 2010 ...

- Require students pose **both** question types.

Is the question succinct and well articulated?

- "Pose one good question ..." (with abstract-writing assignment) - Scored using 1 = NOT articulate ... 5 = VERY articulate
- Questioning posing workshop after Q1.
- Q1: generally articulate, but simple.
- Q3-Q7: decline followed by improvement

Guided question posing - 2010

- Assignment: pose 3 types of questions (27 students)
- Preliminary results: - 'Grading' via rubric. - Questions posed for: • 2 articles in Sept. • 1 article in Nov. - Questions get better. - Class consistency improves (std error).