UBC Earth and Ocean Sciences
Science Education Initiative

BC ESAC: Targeting Challenging Concepts with In-Class Exercises

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Today's plans

1. Feedback obtained from "homework".
2. CWSEI perspective
3. Example
4. Work together to develop active, in-class, learning opportunities.

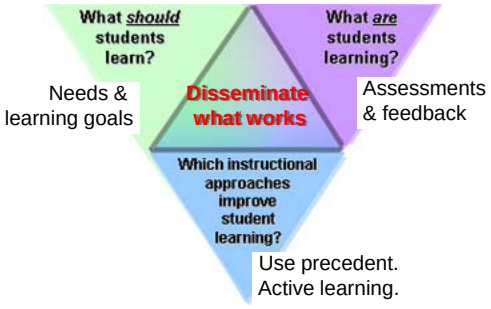
1. Feedback you provided

- Eleven different "challenging concepts".
- Dominant pedagogies:
  - Lecture, demonstration, labs with samples
- A few mentioned …
  - Discussion, lecture activities, field
- Learning goals for students?
  - Yes=3 No=2 "implicit"=2 NotSure=2
- Feedback?
  - Yes=3 blank=3 NotSure=2 "self-assessed"=1

The eleven challenging concepts

1. Lithosphere includes the crust **and** upper mantle.
2. Mantle includes **both** melted and solid - rigid and plastic.
3. Crystalline metamorphic rocks do **not** originate from the crystallization of melts.
4. Identify relevant hazard for a given setting and geography.
5. Cleavage vs fracture, & mineral cleavage/fracture vs rock fracture.
6. Kettle-hole lakes and the source of the water.
7. Texture of igneous rocks.
8. Geo-mag reversals relating to seafloor spreading.
9. Greenhouse gas warming versus stratospheric ozone depletion.
10. Use / application of chemical formulae.
11. Plate tectonics.

2. CWSEI* perspective on activities in class



*Carl Wieman Science Education Initiative

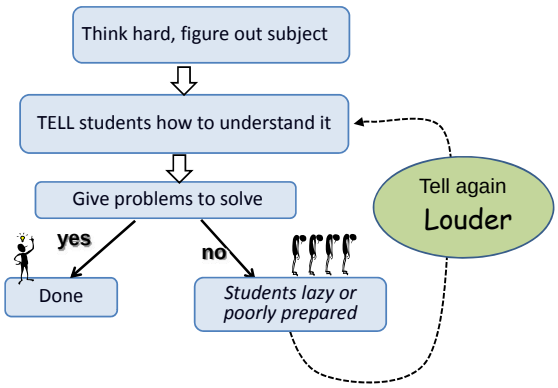
http://www.cwsei.ubc.ca/

CWSEI perspective on activities in class

- In EOS …
  - 5 year funding – 4 full time GeoScientists
- Focus on
  - Helping faculty develop active, evidence-based practices.
  - Modifying courses WITH faculty.
  - Measuring results.
- What framework or models?
  - Consider two education models …

http://www.cwsei.ubc.ca/

Science education Model 1 (We've all used for many years)
http://www.cfa.harvard.edu/sed/events.html



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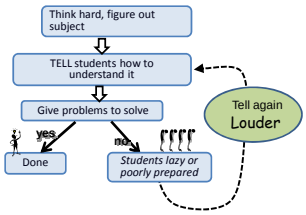


Worked OK, especially for 18th 19th 20th century learning.

BUT … what students must learn is now **complex!**

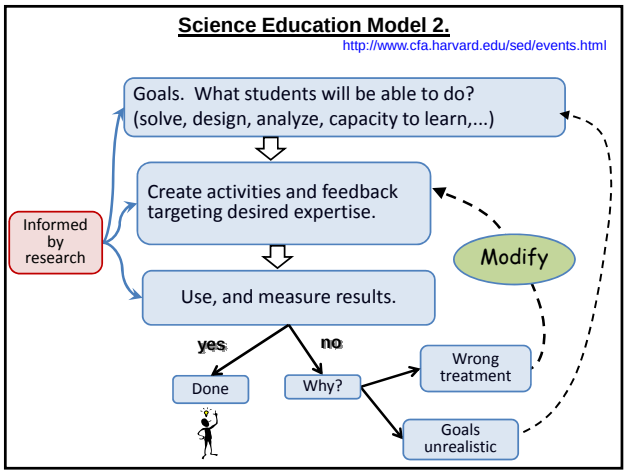
A different model is needed.

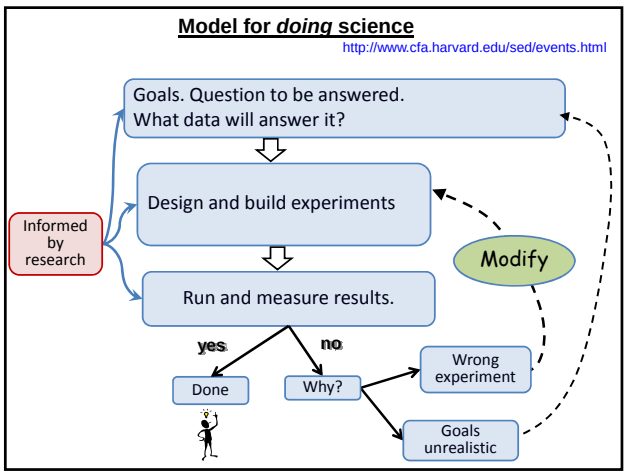
Principle shortcomings …

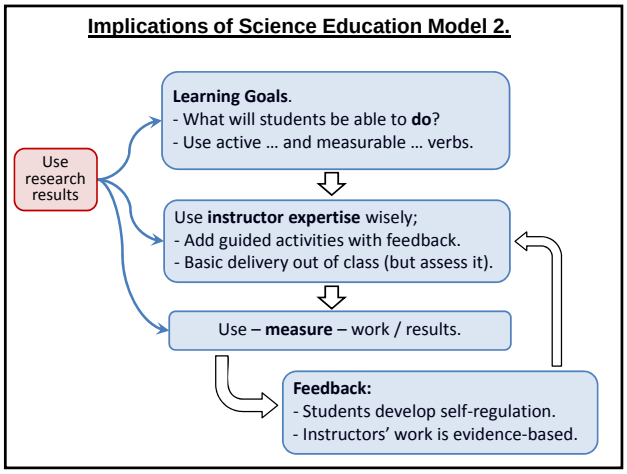
- Characteristics of expertise*
  - factual knowledge
  - Organizational framework ➔ effective retrieval & application
  - Ability to monitor own thinking and learning
    "Do I understand this? How can I check?"
- New ways of thinking…
  - require MANY hours of intense practice with guidance & reflection.
  - Change brain "wiring".

Model 1 only supports this !

*Cambridge Handbook on Expertise and Expert Performance


Science Education Model 2.
http://www.cfa.harvard.edu/sed/events.html
Goals. What students will be able to do?
(solve, design, analyze, capacity to learn,...)
Create activities and feedback targeting desired expertise.
Use, and measure results.
Informed by research
Modify
yes
no
Done
Why?
Wrong treatment
Goals unrealistic


Model for doing science
http://www.cfa.harvard.edu/sed/events.html
Goals. Question to be answered.
What data will answer it?
Design and build experiments
Run and measure results.
Informed by research
Modify
yes
no
Done
Why?
Wrong experiment
Goals unrealistic


Implications of Science Education Model 2.
Use research results
Learning Goals.
- What will students be able to do?
- Use active ... and measurable ... verbs.
Use instructor expertise wisely;
- Add guided activities with feedback.
- Basic delivery out of class (but assess it).
Use – measure – work / results.
Feedback:
- Students develop self-regulation.
- Instructors' work is evidence-based.

3. Example - apply the framework

- Needs
- Active learning (precedent based)
- Assessment …
  … with feedback

One aim is to turn "*show and tell*" into "*discover, practice deliberately, & experience*".

Apply the framework

First, 'needs' implies *learning goals*, so …

- Which helps students direct their studies?
  1. Learn material presented in the lecture.
  2. List hazards and their causes related to volcanism.
  3. For any given location near a volcano, identify which type of volcanic hazard is **most** significant, and explain why.
- Which helps instructors 'see' thinking & adjust teaching

Apply to a challenging concept:

Students do not seem able to apply knowledge of volcanic hazards to a particular local setting.

- Learning goal (likely requires iteration)
  - **Course goal** (one of several): Apply geoscience knowledge to environmental, socio-economic, & political concerns.
  - **A goal for today**: Students should be able to recognize and describe different volcanic products and associated hazards.

Thanks to M.L. Bevier ☺

Apply to a challenging concept:

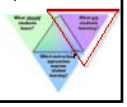
Students do not seem able to apply knowledge of volcanic hazards to a particular local setting.

- Learning goal
- Active learning (precedent based)
  - Basic content via readings, notes, & some lecture.
  - Question and images projected …
  - Discuss with peers (sometimes) ...
  - Complete on 3x5 cards (1-min. paper):
    My friends should know that ____ is the most likely volcanic hazard from Mt Baker that might affect UBC because ____.

Apply to a challenging concept:

Students do not seem able to apply knowledge of volcanic hazards to a particular local setting.

- Learning goal
- Active learning
- Assessment and feedback
  - Participation marks + cards sampled to see student thinking.
  - In the NEXT class: show histogram … or just state results.
  - Discuss maps of source, rivers, lahar volumes & transport, etc.
  - COULD: followup with a similar question using a different setting or hazard.



Today's plans

1. Feedback obtained from "homework".
2. CWSEI perspective
3. Example
4. Work together to develop active, in-class, learning opportunities.

Your challenging concepts …

1. Lithosphere includes the crust **and** upper mantle.
2. Mantle includes **both** melted and solid - rigid and plastic.
3. Crystalline metamorphic rocks do **not** originate from the crystallization of melts.
4. Identify relevant hazard for a given setting and geography.
5. Cleavage vs fracture, & mineral cleavage/fracture vs rock fracture.
6. Kettle-hole lakes and the source of the water.
7. Texture of igneous rocks.
8. Geo-mag reversals relating to seafloor spreading.
9. Greenhouse gas warming versus stratospheric ozone depletion.
10. Use / apply chemical formulae *(context? prior knowledge?)*
11. Plate tectonics *(what specifically?)*

4. Apply to challenging concepts:

Worksheets and groups, or everyone …

Pick a challenge: _____

- Learning goal (always requires iteration)
  - ?
- Active learning (precedent based)
  - ?
- Measurement (assessment)
  - ?
- Feedback
  - ?

Suggestions for activities

- Minute papers
- Analyze analogies (sources, targets, limitations)
- Predict outcomes in demonstrations
- Feedback (“muddiest” point, surprises/puzzles, etc.)
- Worksheets (we’re using one!)
  - Fill in blanks
  - Use projected images
  - Make / adjust / annotate sketches
  - Etc.
- Clickers
- Critique text or lecture figures (assum’ns, limit’ns, etc.)
- “What if” or “troubleshooting” scenarios
- You probably know more … ☺

Running in-class activities

- Students should know the learning goals.
- Use pairs or groups.
- Some incentive is worth it (participation grade, etc.)
- Make activities a habit – start early.
- Circulate! Don't sit watching. Observing visible thinking is very revealing about misconceptions, etc.
- Follow up. Resolving the work is important to
  - establish the importance of the work,
  - set "answers" or limits / constraints / perspectives, and
  - clarify patterns of thinking.

  Use instructor-guided discussions, samples of student work, etc.
- Time: Replace "low level" lecture deliveries with readings AND quick accountability tests. See Moravec etal in references.

Wrap up and conclusion

- Template: the aim is to offer skills rather than direct ideas to specific challenges.
- Resources: hopefully a useful collection of pointers in handouts.
- Contacts:
  STLFs (eg. me) via
  http://www.eos.ubc.ca/research/cwsei/people.html