GEOLOGY and EVERYDAY THINKING:
a metacognitive learning experience designed to inspire future elementary teachers to teach earth science

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and our partner authors

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NORTH CASCADES AND OLYMPIC Science Partnership

Outline of talk

- Key findings - *How People Learn*
- How we applied these in a science sequence for pre-service teachers
- Assessment

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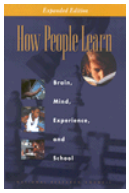
Key Findings from *How People Learn*



1. Students come to classrooms with preconceptions about how the world works.

If their initial understanding is not engaged, they may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but revert to their preconceptions outside the classroom.

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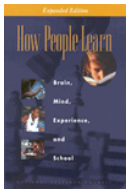

2. Constructing understanding
To develop competence in subject area, students must:

(a) have a deep foundation of factual knowledge;
(b) understand facts and ideas in the context of a conceptual framework; (*sense-making*)
(c) organize knowledge in ways that facilitate retrieval and application.

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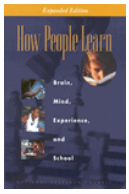

3. A "*metacognitive*" approach to instruction can help students learn to take control of their own learning goals and monitoring their progress in achieving them.

Internal conversation:
"I know I understand _____ because I can _____, but I still can't _____, so I must need to learn _____.

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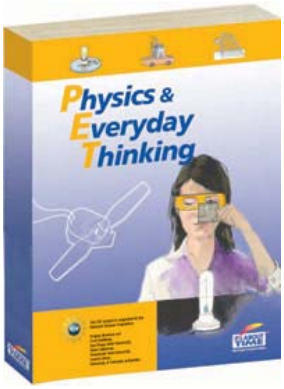
So how did we incorporate these findings?

Highly influenced by *Physics and Everyday Thinking* curriculum (*http://petproject.sdsu.edu*)



Emphasizes
- – Preconceptions
- – Doing and thinking
- – Metacognition

Theme: Transfer of Matter and Energy

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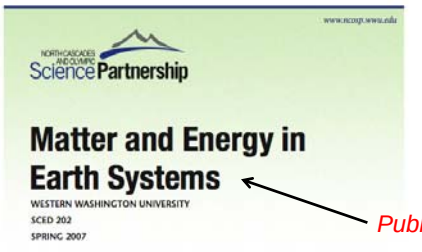
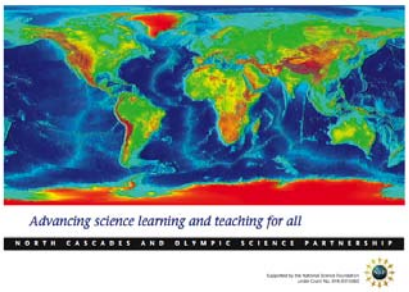
The G.E.T. Curriculum



No lectures: curriculum is frontloaded

Publication title: Geology and Everyday Thinking



Theme: *Solid Earth*

6 learning "cycles" or units that build on each other

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GET - 6 (or 8) Cycles

C1: *How do we know about something if we can't see, hear or feel it?*

C2: *How do rocks tell us about Earth processes?*

C3: *Why does Earth have such varied topography?*

C4: *How do we know about Earth's tectonic plates?*

C5: *How does heat from inside Earth affect Earth's surface?*

C6: *How does energy and matter flow in Earth's Systems?*

C7: How do we interpret Earth's history?

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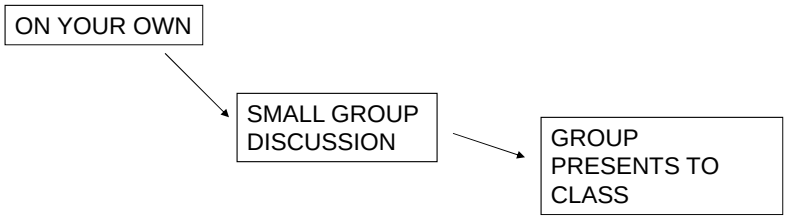
HPL key finding #1:
Address prior conceptions

Each cycle/activity begins with "Initial Ideas"

- "On your own, write down what you think…."
- "Discuss your answers in your group. Prepare a whiteboard that illustrates your ideas and be prepared to share it with the class"



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Addressing prior conceptions

WHAT DOES THIS LOOK LIKE?

1. Share initial ideas in a small group

2. Represent range of ideas on whiteboard

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Addressing prior conceptions

3. Share with the class

4. Generates class discussion

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Addressing prior conceptions

COMPLEXITY OF CONCEPTS GROWS THROUGH CURRICULUM

Example from Cycle 5

INITIAL IDEAS

On your own, answer the following.

How might energy transfer or flow inside Earth cause plate motion?

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HPL key finding #2:
Conceptual sense-making

UTILIZE MANIPULATIVES, DATA, AND EXPERIMENTS

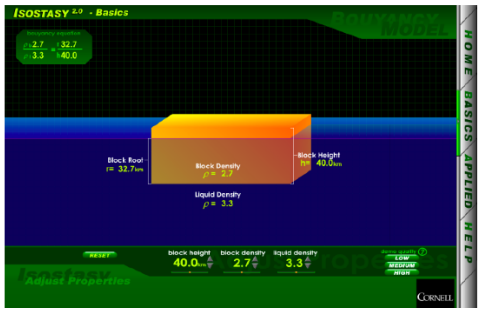
DISCOVERING PLATE BOUNDARIES

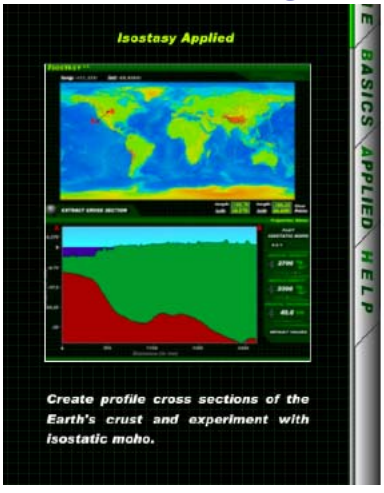
SEISMIC WAVES

http://terra.rice.edu/plateboundary/

Conceptual sense-making

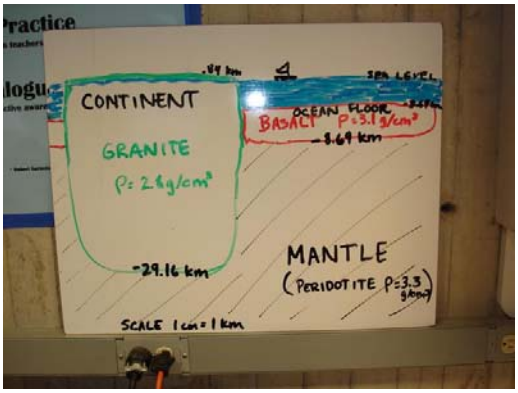
UTILIZE MANIPULATIVES, DATA, AND EXPERIMENTS





Computer simulators
- Isostasy simulator
- Seismic waves
- Mantle convection

Conceptual sense-making



- Sense-making: Continuous writing, discussing, whiteboarding
- Framework: Knowledge builds from previous cycles

Cycle 3: Why does Earth have a bimodal topography?

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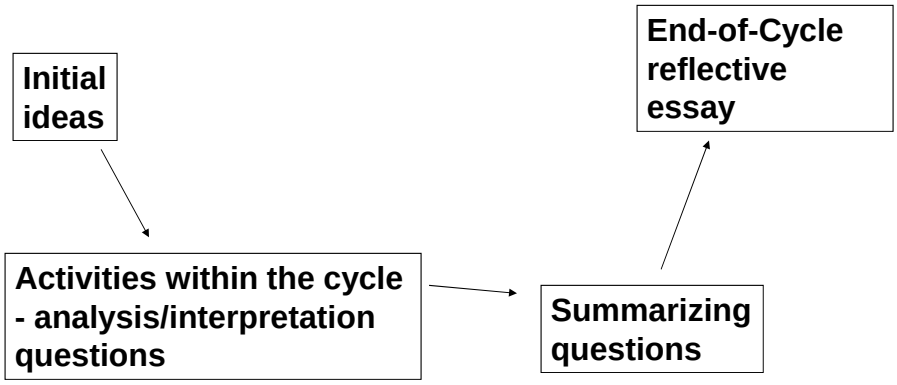
Conceptual sense-making

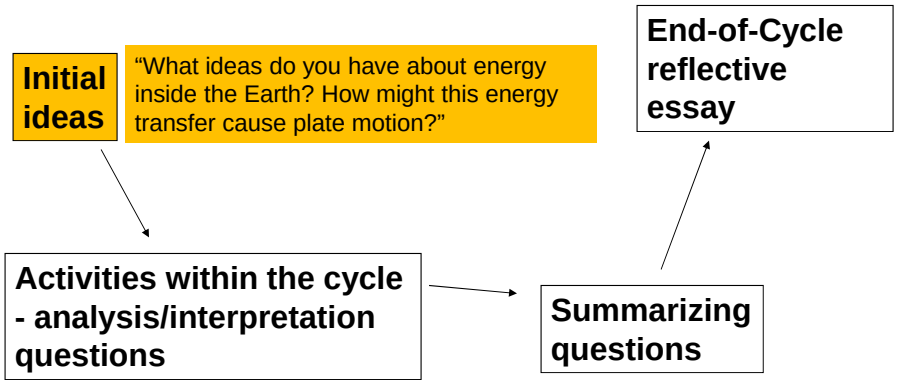
SENSE-MAKING IS NOT THE INSTRUCTOR'S ROLE

HPL key finding #3: Metacognition

Student thinking is tracked in writing from initial ideas through analysis questions to summarizing questions.



Metacognition



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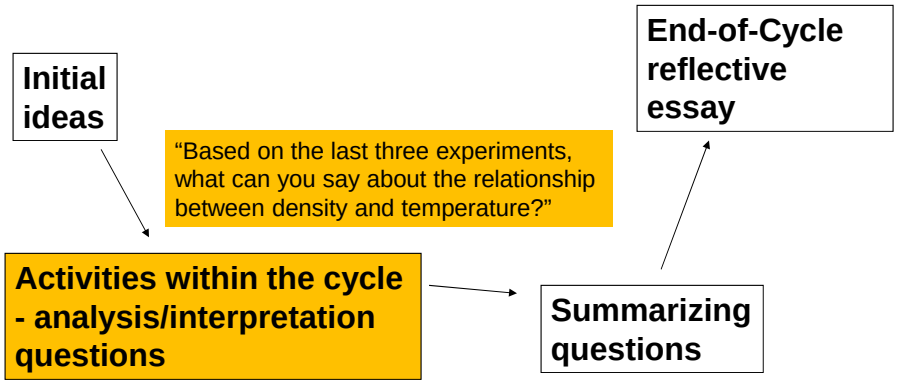

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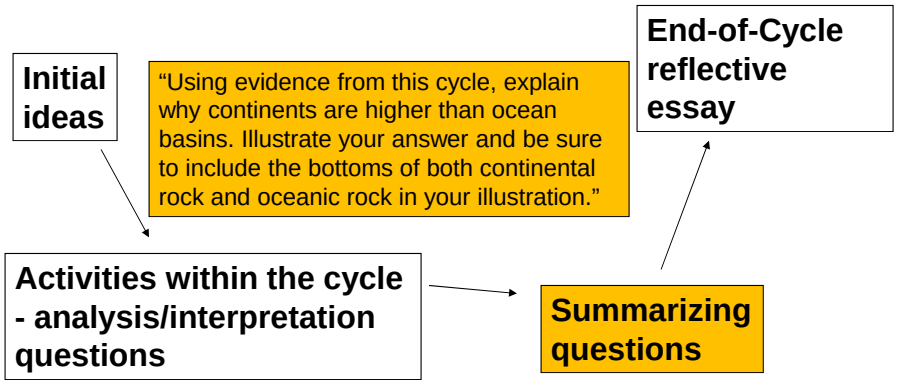
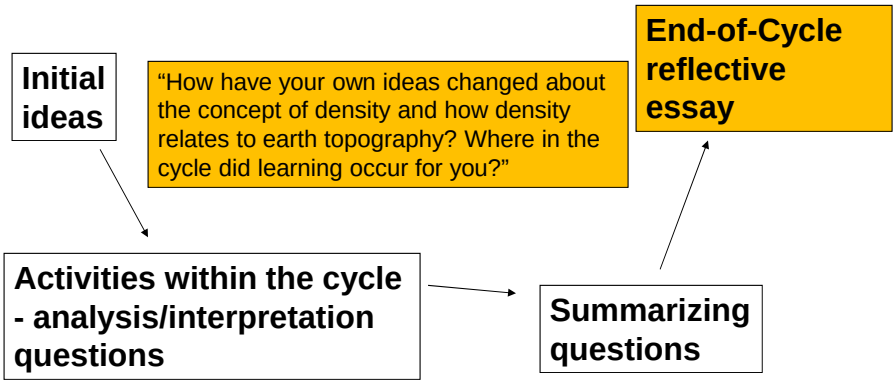


Metacognition



Assessment of Course Effectiveness

1. Tracking a progression of learning

Premise: Meaningful understanding of the earth science concepts of isostasy, convection and plate dynamics requires a solid understanding of density.

Pre- / post-test scores (% correct) on conceptual questions (mean of last 10 classes):

- Density: 32% / 80%
- Isostasy: 19% / 90%
- Plate dynamics: 42% / 84%.

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Assessment of Course Effectiveness

2. Pre-service teachers/non-science majors

Courses	**Pre Content** * # correct % correct	**Post Content** ** # correct % correct	**Gain Scores****
GEO 101 N=97	12.03 *46%*	17.7 *68%*	41%
SCED N=20	12.25 *47%*	20.6 *79%*	60%

** Not a significant difference between the means of the **pretests** for the two courses based on independent sample t-test, p= .78*

***Is a significant difference between the means of the **posttests** for the two courses based on independent sample t-test, p= .001*

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Metacognition and transference to how they will teach

Qualitative evidence: Final Learning Commentaries
In her own words: “Throughout this class I noticed…

Anecdotal evidence: Performance in teaching practicum

G.E.T. (now)

Following the key findings of HPL, this curriculum

- *Surfaces students’ prior conceptions*
- *Helps students establish a framework for understanding difficult geoscience concepts*
- *Helps students think about the process of their learning*

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G.E.T. (soon)

- *New cycles on Earth History (pilot next quarter) and Earth Surface Processes*
- *DRK-12 project lead by Dr. Chris Ohana will examine the effect of these learning experiences on the teaching of our novice teachers (both in practicum and early career)*

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