Concept Sketches

Using Student-Generated Annotated Sketches for Learning, Teaching, and Assessment

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Brief description of this session
Concept sketches are sketches or diagrams that are concisely annotated with short statements that describe the processes, concepts, and interrelationships shown in the sketch. Having students generate their own concept sketches is a powerful way for students to process concepts and convey them to others. In this session, we will explore concept sketches and the learning gains from using concept sketches, provide examples of assignments involving concept sketches, and have available examples of student work.

Background for the technique

The beautiful, detailed diagrams in geology textbooks look wonderful to us but commonly don’t accomplish for students what we would like them to:

- Many students simply skip through the textbook without really examining or internalizing the figures, or they fail to appreciate the value of these figures or use them in constructing their own knowledge.
- Most students do not know how to interpret scientific illustrations, nor can they identify the important factors represented in each (Lowe, 1989, 1993; Schwartz, 1993).
- While students are commonly able to label a diagram with appropriate labels, they are commonly unable to articulate the concepts represented in the diagram or by the labels.

Concept maps (Novak and Gowin, 1984; Novak, 1998) are flow-chart-like or web-like diagrams that help students articulate ideas, identify and arrange key concepts, and see how ideas and concepts are connected to one another. Concept maps have their drawbacks as well.

- While concept maps have been shown to help students construct and organize knowledge and learn more than students who did not construct concept maps (Novak and Wandersee, 1991; Esiobu and Soyibo, 1995), concept maps are most useful as a process rather than as a product to be shared with others.
- Concept maps fail to take advantage of the very visual nature of geoscience and do not preserve the spatial relationships of different features, such as an andesitic stratovolcano positioned above a subduction zone.

Johnson and Reynolds (in review) have proposed that an easy way to improve how students interpret or use scientific illustrations is to allow them to sketch their own versions of the concepts in an active-learning environment. They have developed the idea of concept sketches in which students identify and link key concepts, but retain the spatial relationships among concepts and mimic the more “geologic” portrayals, such as cross sections, that we commonly employ.

Reynolds, Johnson, and Tewksbury have used concept sketches in courses, and Reynolds and Johnson have some preliminary assessment data. Their limited data, when combined with a wealth of general educational research by others, support the positive impact of concept sketches on student learning.

What is a concept sketch?

- A concept sketch is a simplified sketch illustrating the main aspects of a concept or system, annotated with concise but complete labels that (1) identify the features, (2) depict the processes that are occurring, and (3) characterize the relationships among features and processes.
- A concept sketch is more than a labeled diagram. We have attached several examples of concept sketches – a brief study of these diagrams will show how significantly they differ from the standard diagrams that appear in textbooks or that we, as instructors, commonly draw on the board in class.
- In concept sketches, concept captions are connected to particular parts of the sketch with what are called leaders, which are short straight or curved line segments. Many people are tempted to connect concept captions to the sketch with arrows, but research has shown that people associate arrows with movement. Arrows should be reserved for places in the concept sketch where movement occurs (e.g., plate motion, groundwater flow direction, river flow, etc.).

Using concept sketches in class

- In-class use of concept sketches is most successful in terms of student learning if students are actively involved at least in construction of the concept captions, if not the sketch as well.
  - Presenting students with a completed concept sketch doesn’t provide much of a learning opportunity for students.
  - Having students simply copy down concept captions as the instructor lectures and fills in the blanks isn’t much better.
- In-class development of concept sketches can be done successfully in a number of ways:
  - Provide a read-made sketch as a handout or drawn in class on the board. Providing a sketch saves time, can be useful early in the semester to model how to create a sketch, and can be particularly valuable for complex diagrams or abstract concepts.
  - Have students do the sketch during class. This is more time-consuming but allows students to make decisions about what to draw, which forces them to think more deeply about the concepts.
    - Providing “prompts” before students sketch is critical. Prompting materials might be photos, textbook-style illustrations, computer animations, video clips, in-class demonstrations, hand samples, or maps.
    - Before students sketch, ask students to:
      1. list what they think are the key features and processes, versus those things that they observed but that are not essential,
      2. decide how various aspects are related,
      3. brainstorm how to depict the system, and
      4. draw and annotate the sketch.
    - Use the sketching process as an opportunity for students to discuss their ideas with others in the class. Have them compare lists in step 1, share ideas from steps 2 and 3, and compare final concept sketches from step 4.
    - Many in-class techniques can be integrated with the process of creating concept sketches:
      - Have selected students put their concept sketches on the board or on an overhead for discussion, comparison, and critique.
      - Use the jigsaw technique to have groups of students do different but related sketches for comparison.
      - Use think-pair-share for various stages of the process.
      - In an upper level class that is discussion-based, having pairs of students create concept sketches of critical diagrams, graphs, and tables from an article to be discussed can be a very useful way to clarify confusing points.
  - Follow up development of the concept sketch by having students use the sketch to solve a problem. For example:
    - Ask students conceptual questions that hinge on the understanding that
should be portrayed in the concept sketch.

- As students to use their concept sketch to make a prediction.
- Ask students to think about how the system might fail or function abnormally, what the consequences would be, and how it might be “fixed”.
- Ask students to think what might happen if aspects of the system were changed.

**Using concept sketches on homework assignments**

- Having students prepare for class by doing a reading assignment is commonly not very successful. Students read from the first word to the last word but don’t internalize much. Asking students to provide written answers to questions helps, but many students are prone to writing down strings of words that they don’t really understand.
  - Concept sketches can be a very useful way to have students prepare for a class session. Once a student has done a reading assignment, successfully completing a concept sketch requires a deeper level of understanding of the reading.
  - For courses in which students read in the literature, concept caption annotation of selected figures in an assigned article can really force students to address whether they truly understand what they’ve read.

**Using concept sketches in the field**

- Using concept sketches on field trips is a terrific alternative or supplement to traditional field notes. In the field, many students take field notes and dutifully draw sketches, but many students think of notes as a place to write rock descriptions and record orientations of structures and sketches simply as a record of what they saw. Having digital cameras in the field emphasizes the perception that a sketch or a photo is a record.
  - Asking students to make concept sketches in the field forces them to address the question of what processes they see evidence for in the outcrop, what interpretations they can make about development of features, and what evidence supports their interpretations.
  - Making concept sketches in the field forces students to observe more carefully and make decisions about what is and what isn’t important to record in a sketch.
  - Students leave the outcrop having committed to a level of understanding of process and outcome that typically doesn’t appear in the written notes that a student takes in the field.

**Using concept sketches for assessment**

- If you use concept sketches in class, you should also use them for assessment (the idea of authentic assessment, where students are evaluated on the kinds of tasks that are valued in the course).
  - Concept sketches assigned for homework are one obvious method of assessment and can provide the instructor with a better understanding of student background and misconceptions if the concept sketch addresses ideas that have not yet been covered in class.
  - Concept sketches assigned for homework are one obvious method of assessment and can help students learn from textbook reading or articles in the literature.
  - If you teach with concept sketches, concept sketches should appear on quizzes and exams.
  - Project assignments can be constructed around concept sketches. An example of a final project assignment in structural geology involving a collection of concept sketches appears on page 7 of this handout.
  - Rubrics are very helpful in grading concept sketches.
References cited:


Lowe, R., 1989, Scientific diagrams: How well can students read them? What research says to the science and mathematics teacher, Volume 3: Perth, Australia, Key Centre for School Science and Mathematics, Curtin University of Technology.


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**Figure 2.** Concept sketch illustrating the formation of a cone of depression by overpumping of groundwater.
Figure 1. Concept sketch illustrating a divergent oceanic boundary.
Figure 3. Map-view concept sketch illustrating a meandering river.