ON-RAMPS
to more effective teaching in tectonics

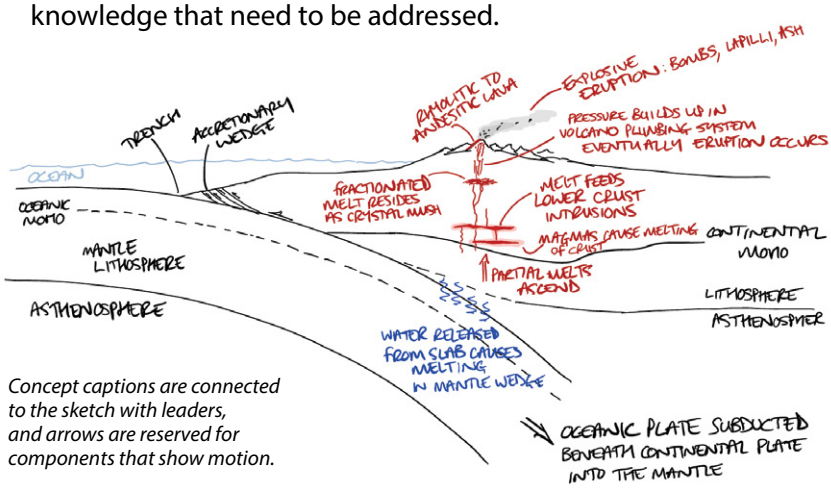
Concept sketches

Students generate sketches or diagrams annotated with concise statements about processes, concepts, and relationships to demonstrate understanding of a system.

A simple example

SCENARIO: The next topic in your tectonics course is arc volcanism. As pre-class homework, have each student draw a sketch that illustrates their current knowledge about the origin of arc magmas and the processes leading to arc volcanism.

1. Rather than having students draw a simple labelled cross section, have students create a *concept sketch* that includes not only labels for key components but also short *concept captions* describing what processes occur and where, what products are formed, and how both relate to the nature of typical arc volcanism.
2. Have students submit concept sketches before class so that you learn where students have misconceptions and gaps in knowledge that need to be addressed.



Concept captions are connected to the sketch with leaders, and arrows are reserved for components that show motion.

Why add concept sketches to your course?

- Constructing concept sketches helps students from intro level to graduate seminars move beyond mastery of terminology to higher level thinking about concepts, processes, and products.
- Concept sketches require students to translate what they have learned into their own diagrams and concept captions, promoting information transfer from short- to long-term memory and consolidating understanding.
- Concept sketches provide an opportunity for students to develop and practice 3D spatial thinking and sketching skills – both are important for geologists.
- Concept sketches can enhance all steps of the learning cycle from engagement to exploration, explanation, elaboration, and evaluation.
- Concept sketches paint concise visual pictures that can be graded more quickly than written descriptions and that provide a clearer picture of student thinking than written answers, which can be paraphrased from a text source.

How much class time does it take?

- Allow at least 15-20 minutes for in-class sketch construction. Peer review takes a similar amount of time.

Tips for success

- Construct a sketch together with your students in class as a first step to model how to organize and explain what they know. Build a simple labelled sketch first and then, together, make it into a concept sketch.
- Emphasize that concept sketches show processes, products, and interrelationships directly on the sketch and are more than labelled diagrams or captioned pictures.
- Model the use of different colors or symbols to convey differences among features, processes, and relationships.
- Encourage students to start by listing key features and processes, and to develop a plan for how best to depict the concepts and interconnections among features/ processes before they begin the actual concept sketch.
- Be upfront with your students about the benefits of concept sketches, from enhancing learning to developing skills for creating figures that communicate effectively.
- Construct sketches yourself before giving an assignment to the class. This will help you evaluate time requirements, determine the important concepts, and develop a rubric.
- Assess concepts conveyed, rather than quality of artwork, and encourage students not to worry about their artistic abilities. Emulating instructor concept sketches early can help students learn how to choose elements to make simple and effective line drawings.

The On-Ramps Project provides quick-start guides for faculty interested in incorporating successful and easily implemented teaching strategies to improve student learning in the broad field of tectonics. The Project was funded by NSF grant EAR1841227 and grew out of a recommendation in the 2018 community vision document Challenges and Opportunities for Research in Tectonics.

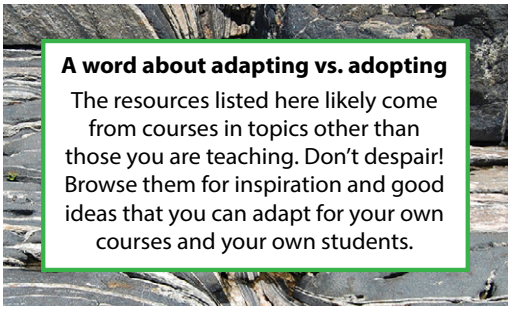
Examples and variations on concept sketches

- **Alternatives to blank-paper sketches.** Instead of having students draw their own concept sketches, provide a graphic or image to which students add their own concept captions. Photos, diagrams, graphs, equations, MATLAB scripts, kinematic models, maps, cross sections, a key paragraph of text, a well log, a seismic profile - the possibilities are endless.
- **Use a variety of prompts.** Videos and other visual materials can serve as excellent jumping off points for either student-drawn concept sketches or ones for which you provide a central graphic. Showing several different images that illustrate the same concept and having students make a generalized sketch that captures the important common elements is also a useful strategy.
- **Collaborative sketches.** Try assigning different aspects of the same system to members of a group (*e.g.*, as a jigsaw activity) or nest concept sketches of the same system at different scales. Limit groups to no more than four to encourage engagement of all students.
- **Assessment.** Teach and assess with the same techniques. Concept sketches are great assessment tools because they test understanding over memorization by asking students to synthesize material. Use with just-in-time approaches to assess what students already know. Use in final exams or weekly quizzes as a way to test comprehension.
- **Pre-class preparation and post-class reflection.** Because concept sketches facilitate summarizing, integrating, and synthesizing knowledge, they are a great tool for preparing students ahead of class (*e.g.*, having students summarize assigned reading as concept sketches) or for reflection after a class meeting (*e.g.*, asking follow-up questions and having students review/critique their own concept sketches in the context of what they have just learned in class).
- **Integration with field sketches.** Field sketches typically focus on detailed description and feature identification. Combine those with information from maps, cross sections, reports, and other field data into an overarching concept sketch that summarizes the processes and relationships as well as features.
- **Preparation and wrap-up for discussion.** To prepare students to discuss journal articles, have students create concept sketches of the key figures in the papers. If students can prepare good concept sketches, they will be well-prepared for discussion. Following discussion, have students develop a group sketch as a community resource for recording understanding and further questions.
- **In a research seminar.** Use group concept sketches to develop ideas for future research and strategies for addressing those ideas.

Resources on concept sketches

From the NAGT portal *Teach the Earth*

- Assessment using concept sketches on quizzes or exams.
- Using a concept sketch to evaluate student understanding of fossil energy and power generation.
- Calculating relative plate motions in Google Earth or MATLAB and translating to big-picture understanding with a concept sketch.
- Constructing a concept sketch to explore changes in Earth systems and the evolution of land plants.
- Using concept sketches in the field and for a final field assignment.



A word about adapting vs. adopting

The resources listed here likely come from courses in topics other than those you are teaching. Don't despair! Browse them for inspiration and good ideas that you can adapt for your own courses and your own students.

Research paper on concept sketches

Johnson, J. K., & Reynolds, S. J. (2005), Concept sketches–using student-and instructor-generated, annotated sketches for learning, teaching, and assessment in geology courses: Journal of Geoscience Education, v. 53, no. 1, p. 85-95.

More On-Ramp pdfs & resources: serc.carleton.edu/onramps/index.html

- What are On-Ramps?
- Interactive lectures
- Brainstorming
- Concept sketches
- Jigsaws
- Compelling discussions
- Quantitative skill-building
- A just-in-time approach
- Case studies
- Gallery Walk
- Flipping the classroom
- Beyond the tyranny of coverage
- Designing effective courses

Concept sketches On-Ramp authors: Jamie Kirkpatrick and Carolyn Tewksbury-Christle.
On-Ramp Project leads: Phillip Resor, Barbara Tewksbury, Jennifer Wenner. **Additional authors:** Kim Blisniuk, Cailey Condit, Anne Egger, Kyle Fredrick, Sara Mana, Kendra Murray, Beth Pratt-Sitaula, and Christine Regalla. **Graphics:** p. 1, J. Kirkpatrick; logo - C. Tewksbury-Christle; photos - banner & p. 2, C. Gerbi.