ON-RAMPS
to more effective teaching in tectonics

Brainstorming

Students generate a wide range of ideas for discussion, for finding solutions to problems, for approaching questions, for explaining results, or for preparing to explore a new topic.

A simple example

SCENARIO: The next topic in your tectonics course is gravity anomalies. Instead of starting with a lecture:

1. Ask students to brainstorm among themselves and make a list of everything they think they know about gravity.
2. Compile a list of everyone's ideas on the board.
3. Have students look over the list, and, as a group, flag ideas that they think might be inaccurate.

Why add brainstorming to your course?

- The class is immediately engaged in the topic, instead of waiting for you to tell them about it, and all students are engaged because they brainstorm their own lists before the composite list is assembled.
- By searching their mental files for what they already know, students collect their prior knowledge and bring it to the front of their minds ready for use.
- Making a composite list generates more ideas than an individual student or pair of students will come up with.
- By listening to your students' ideas, you learn about misconceptions and gaps in knowledge that you didn't know they had (and some are astonishing!). These must be addressed for students to be successful.
- Revisiting the list later allows students to correct gaps and inaccuracies and validate what they have learned.

How much class time does it take?

- A simple brainstorming session like this typically doesn't need to take more than 10 minutes or so.

Tips for success

- Have students work in twos or threes first - that way, each person has the support of one or two other people in the room for their list of brainstormed ideas. Pairs and trios are good because it minimizes "social loafing".
- Go around the room in round robin fashion, and have each pair add one new thing to the composite list.
- Put every idea up without value judgement - criticism of volunteered ideas is not allowed.
- Some pairs will have longer lists than others, so allow teams to "pass" if they have nothing new to add.
- Asking students to assess the list after it is finished gives them a chance to point out items that strike them as "off" without having an idea tied to any one person. It's best if students don't have to say why they think an item is off, which reduces the apprehension about being wrong.
- Resist the urge to agree or disagree or to point out misconceptions. Simply flag them and say we need to keep an eye on this, and we'll come back to this list later.
- Be sure to record the composite list so that it can be re-visited later. A photo with a smart phone can either be brought up later on the screen or transcribed into text.

Examples

- **Research questions.** You have a QuakeCaster device for simulating earthquakes (a board with non-skid surface, a winch, and granite blocks or bricks). Instead of instructing students what experiments to conduct, you have students brainstorm a long list of possible research questions and then allow teams to choose questions to investigate.
- **In the field.** At the first field trip stop, rather than providing a list of the kinds of observations students should make and the kind of data they should collect, have them brainstorm a composite list, use that list for the first stop, re-evaluate the list at subsequent stops, and consolidate a final list at the last stop of the field trip.

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.

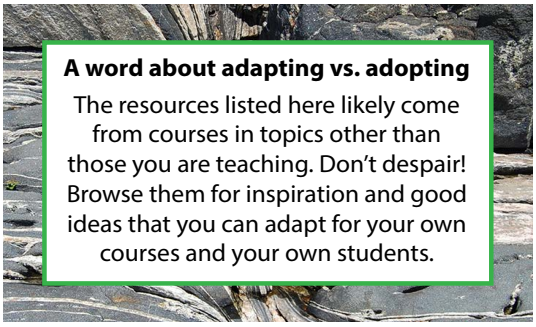
More examples & variations on brainstorming

- **Demonstrations with different variables.** You have videos of several analog models of thrust faults, and students are clear on differences in conditions among the different models. Have the students brainstorm explanations for why models with different conditions generated different kinematics and structures.
- **Brainstorming comparisons.** In order to reinforce concepts of controls on dynamic landform evolution, have students brainstorm evolution of a given set of landforms under different climate conditions or on another planet such as Mars.
- **Data sets.** Pose a question and have students brainstorm data sets that could be used to address the question.
- **Why study X.** Students tend to compartmentalize their courses. Have them brainstorm the relevance of what they are learning in your course for addressing questions in hydro, paleo, seds, glacial geology, etc. and the role of other disciplines for solving problems in your course topic.
- **Getting beyond a simple model.** Toward the end of an upper level tectonics class, have students brainstorm the aspects of real-world plate boundaries that do not fit a simple, intro geo-level model of plate tectonics and what the significance of those exceptions might be.
- **Social responsibility as a geoscientist.** Have students brainstorm creative ideas for informing the public about tectonics-related hazards and for helping people make decisions that will lower their own risk.
- **Alternative to a lecture about the components of structural analysis.** Show a picture of an outcrop with spectacular deformation, and have students work in pairs to make a list of all the questions they could ask about what they see in the picture.
  - As each pair offers a question, add it without comment to one of 3 **unlabelled** sections of the board, one section each for descriptive, kinematic, and dynamic questions.
  - After you have added all student questions, have students discuss what makes the questions in the three sections of the board different from one another.
  - If one section is short on example questions, have them brainstorm others to add that are similar in type.
  - Have students decide if there are questions in any of the lists that don't "fit", and move them to the correct section.
  - Give a mini-lecture consolidating the differences among descriptive, kinematic, and dynamic analysis.

Resources on brainstorming

From the NAGT portal *Teach the Earth*

- Brainstorming ideas about mass-wasting mitigation and preparedness as part of an activity on landslide factors.
- Brainstorming using the Gallery Walk technique.
- Brainstorming research questions in the field as part of an open-ended field inquiry project.
- Brainstorming and analog models of normal faults.
- Reinforcing groundwater concepts by brainstorming comparisons between groundwater flow and oil migration.



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 brainstorming

Isaksen, Scott G. and Gaulin, John P. , 2005, A reexamination of brainstorming research: Implications for research and practice: Gifted Child Quarterly, v. 49 no. 4, p. 315.

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
- Re-thinking coverage & linearity
- Gallery Walk
- Flipping the classroom
- Designing effective courses

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