Example #2 of using the jigsaw technique
with reading assignments on different, but related, topics

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Purpose of the jigsaw:

- To have students construct an approximate temperature curve (average temperatures higher than, lower than, or similar to today) for Iceland for the past 1000 years based on a variety of climate proxies.
- Each student studies a different proxy, and the group puts the data together to construct the curve. No one student would have time to study all of the proxies, so this is an ideal assignment for the jigsaw technique.

Part I: preparation before class

- **Questions to guide reading:** If you want to students to come well-prepared for peer-teaching, you should provide them with specific questions to answer as they do the reading. If you don't, they will likely not prepare in the manner you would if you were reading the article and will not be adequately prepared to teach the topic to someone else. The questions in this assignment provide that kind of preparation.
- **Preparation of a handout:** For a topic involving graphs, photos, maps, etc., a handout is a valuable addition to help a student in peer teaching. This assignment requires students to prepare an appropriate handout and bring enough copies for his/her mixed group.
- **Preparation of a teaching sheet:** When asked to peer teach in the mixed group, many students will simply say, "The answer to question #1 is .....; the answer to question #2 is....". This is not what you would do if you were teaching. You would step back from a topic and ask what the most important message was and then decide how to convey it. Asking students specifically to do this improves the quality of peer teaching. This template has a "teaching sheet" that asks for a summary statement plus the ideas that help support that statement. This can be completed ahead of time, or teams can be asked to discuss it and complete it during the team meetings at the start of class. The rule for students, then, is to use the teaching sheet, rather than the list of preparation questions, to make the points during peer teaching.

Part II: in class

- At the start of class, I divide the class into their respective teams to share ideas about how they will teach what they know to a member from the other team and to clear up any confusions. My TA volunteers and I circulate to make sure that each team is on the right track before forming mixed groups.
- After all teams are ready, students pair up with a member from the other team. If there are an odd number of people in the class, one or two groups will have an extra person.

- Each student teaches the rest of the group what he/she has learned, conveying the main points and the supporting evidence.
- The group then puts the temperature curve together on a large sheet of shelf paper on the basis of shared information and discusses several questions listed on the last page of the template.
- The group receives a group grade on the basis of their temperature curve and answers to discussion questions. Individuals receive an additional grade on their preparation and handout.

Climate in Iceland over the past 1000 years

For the next several weeks, we will be looking at climate changes, glaciers, and the spectacular intersection between glaciers and volcanoes in Iceland.

Iceland has what can be termed a "threshold climate" – minor changes in temperature can mean major effects on the population that include crop failure and expansion of glaciers. Reconstructing climate and changes in climate can be done in a number of ways. We'll investigate four ways of reconstructing climate change in Iceland over various portions of the last 1000 years, and we'll consider the limitations of using glacial fluctuations as a proxy for climate change.

Team Preparation for Homework

Team #1: using historical records to reconstruct climate

Read the following article:

Thórarinsson, Sigurddur, 1956, The thousand years struggle against ice and fire: Reykjavík, Bókaútgáfa Menningarsjód s, p. 5-20, 35-40.

Prepare a handout that shows periods of warmer and cooler climate in Iceland over the past 1000 years, along with what evidence Thórarinsson used to draw those conclusions.

Come prepared to teach the rest of the class about the following issues:

a) What is drift ice, and where does it come from? How do the marine currents around Iceland control both the climate of Iceland (which is considerably warmer than one would expect for its latitude – modern Reykjavík has a winter climate not all that different from New York City) and the distribution of drift ice in a typical year in Iceland?
b) In terms of a climate threshold, why are severe ice years particularly devastating for Iceland?
c) Thórarinsson attempts to put together a historical picture of drift ice since the Time of Settlements. What are the limitations of this type of reconstruction, which is based on written historical documents? What overall conclusion does Thórarinsson draw about drift ice over the last 1100 years in Iceland?
d) How have people used changes in cereal cultivation as a proxy for changes in climate? What are the potential problems in drawing correlations between changing crops and changes in climate? What does Thórarinsson conclude?
e) What do historical records suggest about the positions of the margins of outlet glaciers of the Vatnajökull since the Time of Settlements?

Team #2: using historical records to reconstruct climate

Read the following article:

Ogilvie, A.E.J., 1992, Documentary evidence for changes in the climate of Iceland, A.D. 1500 to 1800, *in*, Bradley, Raymond S. and Jones, Philip D., eds., Climate since AD1500: New York, Routledge, p. 92-117.

Prepare a handout that illustrates what the documentary evidence suggests about climate in Iceland between AD1500 and 1800 and what evidence is used to draw the conclusions.

Come prepared to teach the rest of the class about the following issues:

a) The article states that the place in Iceland with the highest precipitation between 1931 and 1960 was as Kvisker, in south Iceland, with an annual average of 3300 mm. By contrast, Myvatn in north Iceland annual average was 394 mm. How much is that in inches per year, and how do these values compare to annual precipitation in Clinton? Why does less rain fall in the north and northeast of Iceland than in the south?
b) What is sea ice or drift ice, and where does it come from? Why is the extent of sea ice near Iceland used as a proxy for direct climate records?
c) What kinds of written sources exist that give information useful to reconstructing climate, and what types of information are available? How does one go about reconstructing climate from the types of information discussed in the article?
d) What does the documentary evidence suggest about temperature and sea-ice variations between AD1500 and 1800 in Iceland, and what does that suggest about the climate overall in Iceland in this time period?
e) What are the limitations in using documentary evidence as a proxy for determining climate?

Team #3: dating moraines using lichenometry

Read the following articles (read them in the following order):

Kugelmann, Ottmar, 1991, Dating recent glacier advances in the Svarfadardalur-Skdadalur area of northern Iceland by means of a new lichen curve, *in*, Maizels, J.K. and Caseldine, C., eds., Environmental change in Iceland: Past and Present: Amsterdam, Kluwer Academic Publishers, p. 203-217.

Caseldine, Chris, 1985, The extent of some glaciers in northern Iceland during the Little Ice Age and the nature of recent deglaciation: The Geographical Journal, v. 151, p. 215-227.

Prepare a handout showing what lichenometry indicates about time periods of glacial advance and recession in northern Iceland over the past 150 years or so. Be sure you also have maps to illustrate your points.

Come prepared to teach the rest of the class about the following issues:

a) What is lichenometry, and how does it work? How did Kugelman develop a lichen growth curve for northern Iceland?
b) Why do moraines lend themselves so well to being dated using lichenometry? What magnitude error (± how many years) does Kugelman suggest for morainal dates where he tested his lichen curve in Thveradalur? How does this compare to Caseldine's error bars?
c) How do moraines form, and what do they tell us about the behavior of a glacier at a particular time?
d) What do the ages of moraines in Tröllskagi indicate about glacier positions over the past 150 years or so? Why can't the studies be extended farther into the past?
e) How might temperature changes influence the a glacier? To what extent do you think morainal positions and the behavior of a glacier margin can serve as a proxy for climate changes?

Team #4 using remote sensing:

Read the following articles:

Williams, Richard S., Hall, Dorothy K., Sigurdsson, Oddur, and Chien, Janet Y.L., in press, 1997, Comparison of satellite-derived with ground-based measurements of the fluctuations of the margins of the Vatnajökull, Iceland: 1973-1992: Annals of Glaciology, v. 24.

Williams, Richard S., Jr., 1987, Satellite remote sending of Vatnajökull, Iceland: Annals of Glaciology, v. 9, p. 127-135.

Prepare a handout showing what remote sensing of the Vatnajökull indicates about the positions of the various outlet glacier margins between 1973 and 1992. A map would be a really good base to use for such a handout – make sure it has the names of all of the outlet glaciers on it (Williams *et al.* have a nice one in their 1997 paper).

Come prepared to teach the rest of the class about the following issues:

a) What kinds of interesting things did the satellite images reveal about the Vatnajökull that are difficult to study on the ground?
b) How is remote sensing used to compare positions of glacial margins over time? What are the difficulties and limitations?
c) What happened to the margins of the various outlet glaciers of the Vatnajökull over the 20-year time period covered by the study?
d) What do you think the limitations are of using glacier margin positions as a proxy for climate?

Team #5: the problem of glacial surges

Read the following article:

Thórarinsson, Sigurdur, 1964, Sudden advance of Vatnajökull outlet glaciers 1930-1964: Jökull, v. 14, p. 76-89.

Thórarinsson, Sigurdur, 1969, Glacier surges in Iceland, with special reference to the surges of Brúarjökull: Canadian Journal of Earth Sciences, v. 6, no. 4, p. 875-882.

Come prepared to teach the rest of the class about the following issues:

a) What is a glacial surge, how fast does a glacier move during a surge, how long do surges typically last, and what does a glacier look and sound like during a surge?
b) Which glaciers of the Vatnajökull have exhibited surge-type behavior in the 20th century?
c) What might cause a glacier to surge?
d) What do you think the limitations are of using glacier margin positions as a proxy for climate information?

Please bring the following to class on Wednesday:

- **detailed written answers to the questions for the reading assigned to you**, plus the handout we asked you to prepare. ***This must be an individual effort – each person must turn in his/her own work.*** These questions are designed to help you to be sure that you understand the reading and don't miss any important points. If you do not understand anything in your article(s), please come see one of us **early** (not Wednesday noon).
- In class on Wednesday, you will have 5-10 minutes to explain the important aspects of the topic you have prepared to a group of people who have prepared other topics. In order to prepare to teach them, do the following after you have prepared your handout and answers to your questions. Use the form on the next page. ***Again, this must be an individual effort.***

  - Step back, and look at the article(s) and the answers to your questions. Write three to four sentences that summarize the most important message(s) you want to convey about your topic. You will start with this summary when you teach your group.

  - Decide what information you will present to your group in order to support your main points and to explain the topic clearly. Make a list or outline of those topics, as well as specific data/information not on your chart that you will need when you elaborate on what appears in those topics. **Remember that you must not simply recite your summary page – you must sort out what picture you want to paint and *muster the evidence* that your summary statements are correct.**

In class on Wednesday

In your teams

- Discuss the answers to the questions that you prepared for homework, and clear up any confusion.
- Discuss what the big take-home message is from what you've read, and discuss how to teach this message.
- Each person must fill out the "preparing to teach" form, and have me check it.

In mixed groups

- Each person will teach the group about his/her proxy and the interpretation that can be drawn from it about about climate in Iceland in the past. Remember that, if you are listening, and you don't understand something, it's up to you to stop whoever is speaking and ask for clarification. If the group is confused, have me come over and answer your questions.
- On the piece of shelf paper provided, construct an approximate temperature curve (average temperatures higher than, lower than, or similar to today) for Iceland for the past 1000 years based on a variety of climate proxies. Indicate where the interpretation is well constrained and what the evidence is and where the interpretation is poorly constrained and why. Be prepared to defend your curve.

**Note: the group will receive a single grade for the quality of the temperature curve, evidence, and in-class defense. Each individual will also receive a grade for his/her homework preparation and handout.

- **Preparation for teaching – remember that you will have only 5 minutes to talk!!**

Name _____ **Team # & topic**

Summary statement (three to four sentences summarizing the most important messages you want to convey about the article(s) you read.

Outline of topics plus additional facts/data (this outline must contain the topics that you need to cover in order to elaborate on your summary statements and to provide ***evidence*** that your summary statements are reasonable; include any additional facts, data, or tidbits that are not on the handout you prepared)