Garry Simmons

Teaching glaciation

Garry suggests some fun activities to help students make sense of glaciation.

Accompanying online materials

Few UK students will ever have seen a real-life glacier, and glacial action can be difficult to represent in images. Recently, planning a course on glaciation for GCSE students, I was inspired to devise some teaching activities to make the processes more accessible. These incorporated kinaesthetic, ICT and video activities, and are equally applicable to key stage 3 or A level.

The 'Grow your glacier' game

This competitive game is designed to help students understand the dynamics of glacial mass balance (Figure 1). The game simulates growing a glacier, using glass marbles in a U-shaped section of guttering. Each throw of a dice represents a year, and depending on the throw the marble glacier will experience net accumulation (a surplus of ice) or net ablation (a deficit of ice), and the glacier will thicken and lengthen or thin and shorten accordingly. Although the marbles don't simulate the movement of a glacier particularly well, the game is excellent for helping students understand how changes in the glacial budget cause glaciers to advance or retreat. Despite the technical nature of these terms I heard students enthusiastically shouting out 'Yes! Net accumulation!'

Student comments:

This game helped us learn because it was much clearer what ablation and accumulation were. It was enjoyable as the whole class became very competitive.

This game helped me learn because it made me think about the key terms and definitions whilst having fun at the same time. I really enjoyed this because it was very interactive.

Grow your glacier

The aim of this game is to get your glacier to grow the most.

The winner is the group with the most 'ice' marbles.
More marbles = greater ice mass.

Dice throws (1 throw = 1 year)

1. Mild winter with little snowfall; warm summer. Lose three marbles.
2. Mild winter with little snowfall; cool summer. Lose two marbles.
3. Cool winter with moderate snowfall; warm summer. Lose one marble.
4. Cold, snowy winter; warm summer. Gain one marble.
5. Cold, snowy winter; cool summer. Gain two marbles.
6. Cold, very snowy winter; cool summer. Gain three marbles.

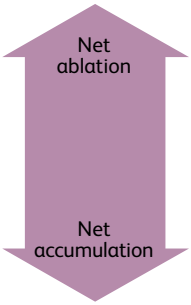

Figure 1: Grow your own glacier game. These instructions are available to download.

Glacier 'goo' demonstration

I am indebted to Neil Glasser, Professor of Physical Geography at Aberystwyth University, for this glacier 'goo' recipe. It is very cheap, fun to make in class and very easy to clean up afterwards. Being elastic, the goo deforms under gravity, so has very similar flow properties to ice (although glacial ice is less elastic and cracks under gravity, creating crevasses).

The ingredients are very cheap: warm water, PVA glue, food colouring and borax (sodium borate) which you should be able to obtain from your science technicians. You will also need a lab coat and a wide piece of guttering, to simulate a U-shaped valley. Mix the ingredients together: the borax reacts with the PVA to create an elastic polymer, aka 'goo'. Dollop the goo into the accumulation zone of the model and allow a double lesson for the goo to fully deform (Figure 2).

'Moraine conveyor belt' activity

Students can find it difficult to understand glacial transportation and deposition, in particular the formation of terminal moraines, and this classroom activity animates these processes. Use a long piece of lining paper, to represent a glacier, sellotaped into one long conveyor belt circulating around a table. Place the table across another one. Allow playdough moraine to fall onto the glacier conveyor. Pull the conveyor and watch a terminal moraine form. Move the table and glacier forward to bulldoze the terminal moraine forward. Move the table back to create some recessional moraines. Students need to understand that moraine falls onto the glacier from above, via freeze thaw weathering, and is drawn into it from below, by plucking. This conveyor represents both sources of moraine.

Student comment:

This helped me learn because I was struggling to visualise how moraine formed and how glacial moraine was involved in the process. By doing the moraine conveyor belt I understood.

Web map and story map

Climate change offers a new approach to teaching about glaciation. 95 % of the world's glaciers are now in retreat. To highlight this dramatic environmental change I created two ArcGIS Online (AGOL) products: a web map and a story map. You can use ESRI's free browser-based GIS software or the school's account.

To create the web map, I researched the historical snout positions of six glaciers and used coloured lines and dates to show how they have retreated since their Little Ice Age maxima. The second step was to use the map journal builder to create the

interactive story map, with photography, maps, text, embedded videos and links. Students can use the story map to learn more about these glaciers (Figure 3). They can also use the measuring tool in the web map to analyse changing annual retreat rates.

Student comment:

The use of ArcGIS Online helped me to see the dramatic retreat of real-life glaciers.

Extreme Ice Survey video

James Balog created the Extreme Ice Survey (EIS) to share time-lapse footage of several glaciers in order to demonstrate the rapid environmental change caused by global warming. These mesmerising videos can be viewed on EIS Vimeo pages and are fantastic for showing students how glaciers flow like slow-moving rivers of ice. The video of the Khumbu Glacier at Everest Base Camp video is particularly helpful. As a school we also purchased *Ice: Portraits of Vanishing Glaciers*, James' wonderful book of stunning photography, and his Emmy award winning DVD documentary *Chasing Ice*.

Student comment:

The time-lapse videos and still photographs created by James Balog helped me understand the rate at which glaciers are retreating and that global warming can be harmful for our environment. They taught me we should do something to reduce the retreat of glaciers.

Google Earth tablet app

Glaciated mountain ranges are some of the most dramatic landscapes on Earth. Huge variations in altitude and steep slope angles are represented well in Google Earth. The tablet version, available free from the App Store or Google Play, is particularly intuitive: students can easily zoom in, pan and tilt to virtually explore a glacier in 3D. This immersive ICT activity always yields the 'wow' factor. It can be used at the start of a course, to help students to understand the concept of a glacier, or later on, to consolidate understanding and help students apply their theoretical knowledge to unfamiliar or 'messy' real-world geography. The desktop version is excellent: but do ensure that vertical exaggeration doesn't exceed 1.5.

Student comment:

I enjoyed this because it helped me visualise the Alps and identify key landforms. It was easier to see what they look like and have a 360º view rather than looking at photos.

Figure 2: The glacier 'goo' demonstration using a landscape model of a U-shaped valley with two corries (I made it during my PGCE year!). **Photo:** Garry Simmons.

Figure 3: A Story map using ArcGIS Online showing glacier retreat for the Athabasca glacier.

Conclusion

Students clearly enjoyed the kinaesthetic activities. Bryony's comment, below, sums up the views of her class perfectly.

Student comment:

I enjoyed these activities because everyone got involved and was able to contribute in a way which made us learn. Additionally, they were very interactive activities which made the lessons more fun and interesting. This engaged the class much more, compared to if we were reading from the board, textbook or worksheets.

Any of these activities will help make abstract physical processes more accessible to students. The kinaesthetic activities, particularly, will provide some memorable lessons for both you and your students. There is clearly a time and cost element to creating some of the resources but once made they can be reused for several years. Have fun with glaciers! | **TG**

Online resources

The instructions for the 'Grow your own glacier game' are available to download. Go to *www.geography.org.uk/tg* and click Spring 2016.

Acknowledgements

With thanks to the class of 2015 at WGSG whose brilliance and hunger for knowledge motivated me to create new learning experiences.

Extreme Ice Survey resources

Chasing Ice DVD: *https://chasingice.com*
Balog, J. (2012) *Ice: Portraits of Vanishing Glaciers*. New York: Rizzoli International Publications
Extreme Ice video: *https://vimeo.com/extremeice*
Khumbu Glacier time-lapse video: *https://vimeo.com/33809028*.

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