

Maths of Voting OTS Masterclass

Thanks for helping with this Masterclass session! Your support is much appreciated.

The session leader should be able to tell you more about the content of the session, and exactly how they'd like you to help, but this sheet should give you some basic information you may find useful. If any of this seems obvious to you, that's great!

In general, for Masterclass sessions:

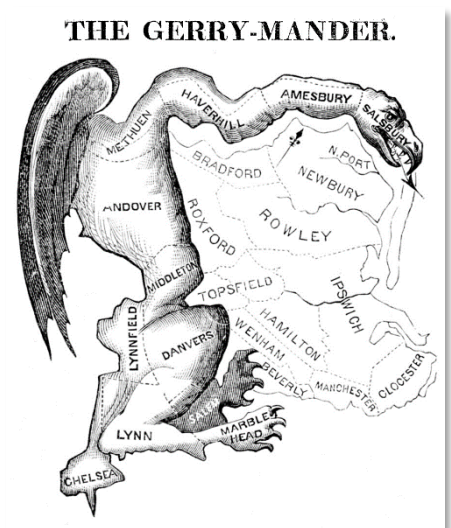
- While the session leader is talking to the group, don't interrupt them or distract the students unless something is wrong that needs fixing urgently. You should also watch and pay attention to what they're saying, to set a good example.
- If things need handing out to the students, wait for the session leader to signal you to do this, as it can distract the students if you start to hand things out before they're ready.
- If the students are given a task to work on, you should circulate the room to talk to the students. Wait until they've had a chance to tackle the problem before you interrupt them, and encourage anyone who looks like they haven't started yet.
- Try not to give away the answers to the students, especially if they're working on the problem and about to discover it for themselves - if they are really struggling, you can give them a hint or suggest where they might start looking. Asking questions about the problem is a great way to get them thinking along the right track.

In this session:

This session introduces students to electoral maths, by exploring how different voting systems, including First Past the Post, Alternative Vote, and Borda, calculate who wins an election. Students will evaluate the advantages and disadvantages of these different electoral systems as well as evaluate to what extent these systems are fair. Students will then use the knowledge and skills from this exploration to discuss and develop their own voting method.

The main activities are:

- 1. Can you gerrymander? (Worksheet 1)** Students work through a mathematical/logic puzzle to demonstrate how gerrymandering works in practice. Students are given three maps of voters, for either Blue or Magenta, and are asked to draw constituency borders to allow Magenta to win overall. The first two maps have several solutions; any solutions that give 6 continuous constituencies (i.e., with no gaps between squares) where at least 4 of them have majority Magenta voters, will do. The third map is impossible; the minimum number of voters needed to have at least 4 constituencies have at least 4 Magenta voters (and thus be possible to win) is 16, but this map does not contain enough Magenta voters for a win. Similarly, in the extension question, there are currently 12 magenta voters in the map, so 4 of the Blue voters must turn Magenta to make a win possible!



- 2. Alternative Vote (Worksheet 2)** Students work through an example and then use Alternative Vote to work out the winner in a vote of favourite pizza toppings. Students need to work through the table of preferences carefully and systematically – there is no immediate majority, so in the first round the topping with the fewest votes (veggie) must be eliminated. When an option is eliminated, it is as if the option is not there. After second preference votes of previously-veggie voters have been distributed, there is still no majority, and this time Pepperoni is eliminated. With their votes redistributed, Cheese now has 7 votes (i.e., majority) and wins! In the extension question, this same system is applied to a vote between UK national parties. After going through the same process, Conservative is given a majority.

3. Borda (Worksheet 3) Students use Borda to determine the winner in the pizza toppings vote.

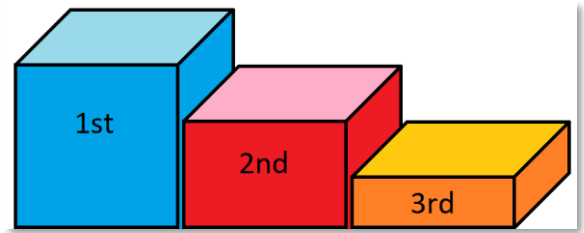
Similar to the Alternative Vote worksheet, students must work through the pizza topping preferences systematically, counting how many votes each topping gets at each level of preference. Then, the

number of points gained at each level can be calculated using the given formula (1st preference = 3 points per vote, 2nd = 2 points per vote, etc.)

This will result in a tie between Cheese and Pepperoni, with each having 20 points.

In the extension, students are asked how the tie could be broken. There are many possible options, including many that you may not have thought of! Any reasonable solution will work, but some examples include repeating the vote with just the two winners, a coin toss, or a logistical choice e.g., whichever is cheaper, or choosing cheese to accommodate any vegetarians.

There are also many possible answers that will change the winner, like if any voter changes their order of preference for cheese and/or pepperoni. Likewise, many different systems for awarding points could change the winner, for example massively increasing the weighting for 1st preference, or deducting points for last preference.



4. Deciding on a system (Worksheet 4) In groups, students run a mock election using their choice of the systems they have learned about, or a randomly selected other system.

This is a very open-ended exercise. Once systems have been decided, you can go round the groups and ask students what system they are working with, what their ballot might look like because of that, and get them to think about whether the way they are conducting their vote is true to the way that system should work in theory, and if it produces a 'fair' result, and why/why not.

There is a great deal more background information available on a separate sheet, if you would like more detail. There are also more detailed solutions, with worked examples, on another sheet. Please ask the session leader if you'd like to see these.

Thanks again for your help with this session! If you have any other questions, please ask the session leader.