

## Grid Algebra: Solving step by step

Topics	Difficulty range												
Inverse Order of operations Formal notation Solving equations	<table border="1"><tr><td>From</td><td>★</td><td>★</td><td>★</td><td></td><td></td></tr><tr><td>To</td><td>★</td><td>★</td><td>★</td><td>★</td><td>★</td></tr></table>	From	★	★	★			To	★	★	★	★	★
From	★	★	★										
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### Preparation








It is assumed students are comfortable with formal notation and making journeys round the grid. It would be preferable if they have already worked on the ideas in *Inverse journeys*.

Load the grid: *Solving step by step 1*.

Description of grid: 5 columns, tables 1 and 2, do allow negatives. The letter  $x$  is placed in the second cell in row 1. Magnifiers are placed in the start cell and the other cells on a pre-determined journey. The magnifiers are positioned so that the inverse journey will read downwards through the magnifiers.

### Activity (assuming an interactive whiteboard or projection - adapt for a computer room)

- Say that you are going to go on a journey from  $x$  indicating that you will go one cell to the right then down and lastly two cells to the right. The magnifiers are in the cells along the journey. Slowly take that journey and see the expressions gradually appear in the cells and the magnifiers.
- Say that you are going to make the final expression equal to 78 and drag that number from the number box into the final cell. This will appear in the magnified cell to make  $78 = 2(x+1)+4$ . The question is what is the value of  $x$ ? To find out we can take the inverse journey from 78 back to  $x$  and find out what we have to do to 78 to get  $x$ .
- Slowly drag 78 along the inverse journey helping students see how the new expressions appear in the magnifiers. Also try to get students to say what they are having to do to 78 when doing the inverse journey. The screen will then look like the one below on the left.
- Take time for students to look at what changes occur between one line and the next line in the magnifiers. Why, for example, when going from the first to the second magnifier does the  $+4$  disappear from  $2(x+1)+4$  and 78 change to  $78-4$ ? Try to get students to account for such changes.

- Get the students to look at the equation in the  $x$  cell. State that you could now 'solve' the equation by finding out the value of the letter. I suggest you do not actually drag in that number into the cell at this stage due to what I suggest next, although it is an option (and you could always rub out the number afterwards using the 'Rubber' ).
- Click on the peeled back corner of the cell with  $\frac{78-4}{2}-1$  to reveal  $x$ . You are now going to find another way of looking at the journey going from 78 back to  $x$ . Click on the 'Route' button  on the toolbar and two other buttons will appear below it. Click on the 'New route' button  and click on the cells involved in the inverse journey starting with 78. After finishing on the  $x$  cell click on the 'New Route' button again so that it is raised. Click on the 'Expression Window' button  and a window will appear showing the expressions involved in the journey from 78. Click on the 'Display As Equations' button  in this window and both the original and inverse route will appear as equations just like the series of magnifiers. (You will need to click on the expression  $\frac{78-4}{2}-1$  in the bottom magnifier so that it moves to the LHS of the equation so that the magnifiers now copy the Equation Window). The screen will now look similar to the one below on the right.
- Keep the Equations window and also the magnifier which has  $78 = 2(x + 1) + 4$  and close the other magnifiers. Click on the 'Hide grid' button  so that just these two windows are seen. Now move the mouse towards the bottom edge of the Equations Window so that the mouse changes to a double arrow. Click and drag the bottom of this window upwards so that only the first line is seen (which is exactly the same as the magnified cell). Get students to write down on paper what the next series of equation lines will be. Check with the person next to them to see whether they agree. It has to be written correctly in formal notation just how it is written in the software. Then reveal each line one at a time for them to check.
- Repeat with *Solving step by step 2* by producing the expression  $\frac{2d-8}{2}$  and choosing to drop in a number such as 31 into this final cell. Perhaps try to get students to predict what will appear as you are creating the expression and its inverse and how it will be written.
- Click on Clear from the top menu and choose All Cells. Drag a letter into a cell and make a journey. Put a number into the final cell to create an equation. Put a magnifier  into that final cell to show the equation. Then click on the 'Route' button and then 'New Route' and draw the inverse route from the number back to the letter. Click again on 'New Route' to indicate you have finished creating the route and click on 'Expression Window' to get the series of expressions from the number and choose 'Display As Equations'. Then bring up the bottom

of the Equations Window so that just the first equation is shown. Lastly click on 'Hide grid' and get students to write down what the next lines will be on the way to finally getting an equation which tells you what to work out in order to find the value of the letter. You might want to pre-prepare some files with such situations so that you can load them when in the classroom.

- As you are working on this topic think about introducing key words such as *Equation* and *Solving*.

### Examples of screens

### Extensions/Simplifications

- Journeys can be long or short! Sometimes students enjoy really long ones once they have sense of what they are doing.
- The grid can be changed into one with more rows and so more challenging equations can be created to solve.

### Related Resources

- Handout:
  - *Solving step by step*