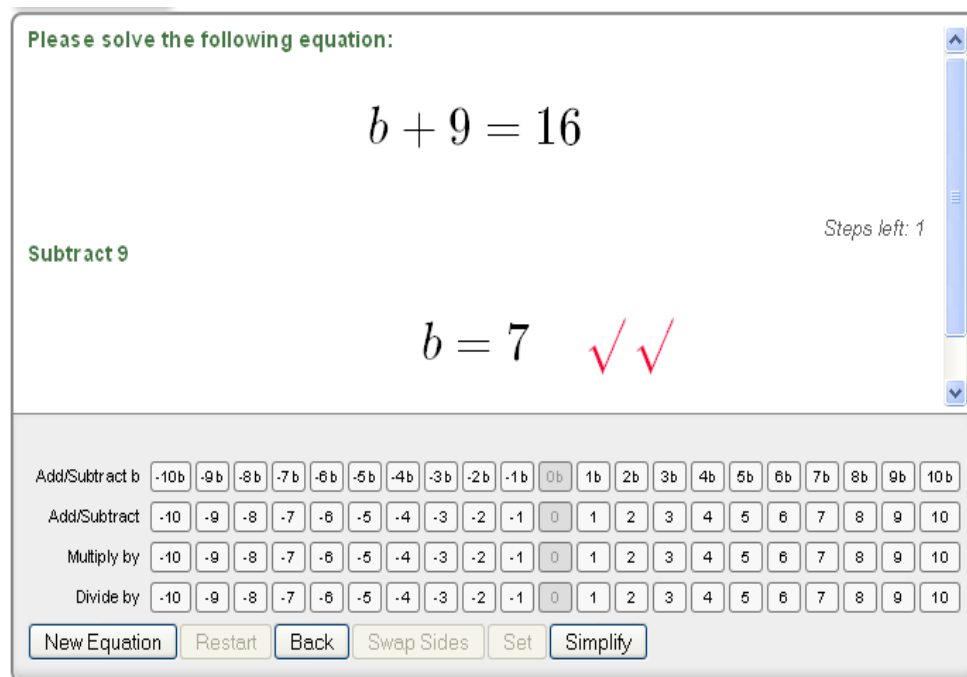# Equation Buster

Version 1.0. Check the site regularly for updates

Introduction

One of the keys to grade C is the ability to solve linear equations. These equations can vary from $2x = 12$ to something as complicated as $\frac{x}{3} - 4 = 3(x+5)$.

We believe that it is crucial that the student understands the process for arriving at a solution for these equations, rather than relying as many do on a haphazard ability to somehow spot the answer, often through inspired guesswork. A new version of Equation Buster, the equation solving activity, is published on MathsNet. You will find it in the Algebra sections of both the Foundation and Higher Levels. You can practice solving equations at various levels of difficulty by choosing the appropriate steps in the appropriate order. In fact it is the finding of the best sequence of steps that is the challenge – not simply getting the answer. The display looks like this:

An equation is given to be solved. Each time you select a new equation it will be different. In the above case the equation $b + 9 = 16$ can be solved in one step. The options available for this step are shown at the bottom of the display. The correct option is to **Subtract 9**. This has been done and the result is shown. The double tick indicates that not only has the

correct answer been found but also that it has been found in the minimum number of steps.

When the **Back** button is available, then any step can in effect be rubbed out and the previous line reverted to. The **Simplify** button will enable any brackets to be multiplied out.

Note that this applet always assumes that the final answer is written, as above, in the form $b = 7$ rather than $7 = b$, hence the presence of the **Swap Sides** button.

Click **New Equation** for another example.

Equation Buster is based on this setup. When the equations are harder more steps are required and they may not be so obvious and of course the order in which the steps are applied will be crucial too. The aim of this activity is to focus attention on the identifying of appropriate algebraic steps and the best order in which to apply them. Clearly most equations can be solved in a number of ways. Here the focus is on the most efficient.

As a simple example, for the equation $\dfrac{x}{-2} = 4$, students may choose to multiply both sides by 2 and then change the sign (by multiplying by -1) but of course the equation can be solved in one step by multiplying by -2.

Levels

One key aspect of Equation Buster is **Levels**. Linear equations have been broken down into levels, which correspond approximately to difficulty together with the number of steps required to solve them.

This table will give you a rough idea of what is included – though this list is likely to change as more types are added in. On the website you will see the levels listed.

Level 1 - 1 step	Level 2a - 2 steps	Level 2b - 2 steps	Level 3 - 3 steps
$ax = b$ $$\frac{x}{a} = b$$ $x + a = b$	$ax + b = c$ $a(x+b) = c$ $ax = bx + c$	$$\frac{x}{a} + b = c$$ $$\frac{x+a}{b} = c$$ $$\frac{ax}{b} = c$$	$$\frac{ax+b}{c} = d$$ $$\frac{a(x+b)}{c} = d$$ $$\frac{a-bx}{c} = d$$

Level 4 - 3 steps	Level 5 - 4 steps		
$ax + b = cx + d$ $a(x+b) + c = d$ $a(bx + c) = d$	$a(x+b) = cx + d$ $ax + b = c(x+d)$ $a(x+b) = c(x+d)$		

Level 6 - 4 steps	Level 7 - 4 steps	Level 8 - 5 steps
$$\frac{a-bx}{c} = dx + e$$ $a(x+b) = c(x+d) + e$	$$\frac{ax}{b} + \frac{c}{d} = \frac{ex}{f} + \frac{g}{h}$$	$$\frac{x}{a} + b = c(x+d)$$ $$a(x+b) = \frac{cx+d}{e}$$

There is one page called "Choose your level" where you can access all these levels together.

One on one challenge

In a new development, students can challenge each another. One creates the equation, "sets" it, then the second attempts to solve it.

Equations can therefore be made as complicated as you like. As before the emphasis is on solving the equation in the minimum number of steps – usually the same number that it took to create the equation.

For example, starting with x = 3 and applying the steps **Add 4**, **Multiply by 2**, produces the equation 2x + 8 = 14, which can then be solved by the steps **Divide by 2**, **Subtract 4**. (or **Subtract 8**, **Divide by 2**).

Teaching points

Use this applet to investigate the concept of "doing" and "undoing" or inverse operations.

Is it every possible to solve an equation in less steps than were required to create it? Investigate…

It is possible. For example if the first student uses the consecutive operations **Add 4**, **Subtract 7**, then these are equivalent to the single operation **Subtract 3**. Likewise **Multiply by 6**, **Divide by 3** is equivalent to **Multiply by 2**.

Create your own equation

In another new development, more complex equations can be created and then set as tasks for the students to solve. For example equations found in a text book could be entered by the teacher and then presented to the class as a challenge.

In this case the minimal number of steps will not be known. One way of using this activity might be for the teacher to set an equation like:

$$\frac{2x}{3} + \frac{3}{5} = \frac{x}{2} + \frac{4}{7}$$

And then challenge the class to find the least number of steps required to solve it.

Can $\dfrac{x}{-2} = 4$ be solved in 1 step?

Can $\dfrac{x}{12} + \dfrac{2}{3} = \dfrac{1}{5}$ be solved in 2 steps?

Can $\dfrac{2x}{3} + \dfrac{1}{4} = \dfrac{x}{2} + \dfrac{2}{5}$ be solved in 4 steps?

Teaching points

How many different ways can you find for solving the same equation?

$4x + 12 = 20$ can be solved in two ways:
Subtract 12, Divide by 4
Divide by 4, Subtract 3

$6x + 12 = 3x + 18$ can be solved in three ways:
Subtract 3x, Subtract 12, Divide by 3
Subtract 12, Subtract 3x, Divide by 3
Divide by 3, Subtract x, Subtract 4

What is the most complicated equation that this applet will solve? How do you go about constructing this equation?

Not all equations will be solvable by this activity. For example if in solving an equation it is necessary to divide by say 17 (or any multiple of a prime number bigger than 13) then there will be no option for this. The display will warn you that you have entered such an equation and you will have to choose another equation.

O-tests

Finally there are on-line assessments, called o-tests. Like o-tests elsewhere on the website, these tests are marked immediately and the scores recorded for viewing later by the student or teacher.

The student scores 1 mark for solving the equation and 2 marks for solving it in the minimum number of steps indicated (3 in the above case). The o-tests cover all the types of equations listed on page 3.

Future developments

We are hoping to introduce other types of equations, for example **quadratic equations, rational equations** and **simultaneous equations**. We are also looking into the possibility of using a school network to enable the teacher to set an equation for all students simultaneously, so there is a race to find the solution.

Equation Buster
Available on subscription at **www.MathsNetGCSE.com**