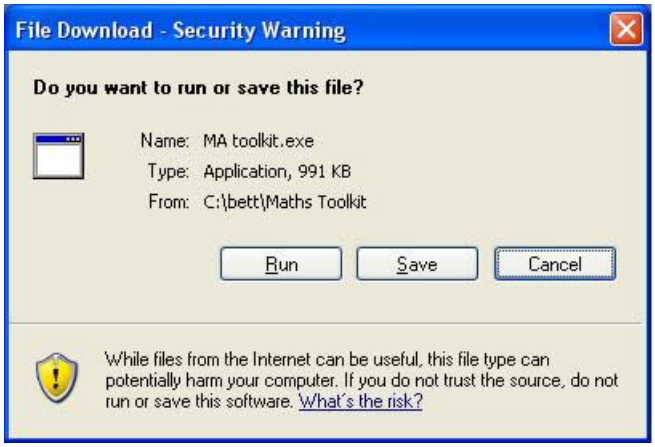
Using the Numberline Tool

General technical requirements and troubleshooting

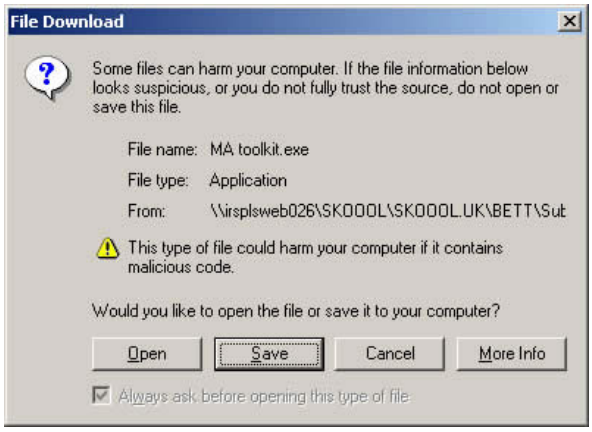
- Intel® Pentium 4 2.2+ Processor
- 256 MB RAM
- Your PC must be running Windows XP (Home or Professional edition) as its operating system.
- You must have Internet Explorer selected as your default web browser, and any pop-up blocker must be switched off for this application.
- The Mathematical Toolkit is designed to run in a Windows environment it will not operate on Macintosh computers.

NOTE: If you are running Windows XP, you must be a Power User or Administrator on your PC to install the Numberline Tool.



After unzipping the file downloaded from TaLe, double click 'maths_numberline_1.8.exe' and most users will be presented with 2 pop-up dialog boxes in turn as shown here.

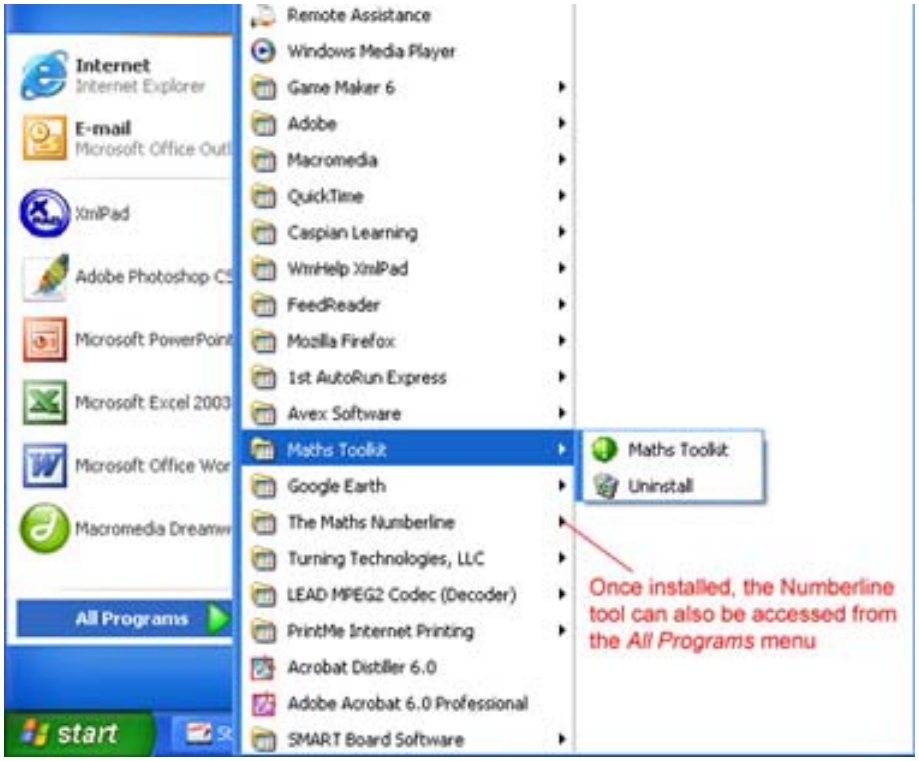
On both of these the user must click "Run", in order to be able to use the Maths Toolkit or the Number line.



Some users will be presented with the dialog box shown here. In this case click "Open", to be able to use the Maths Toolkit or the Number line tool.

These dialogs are part of the Internet Explorer Security Model and are designed to provide protection from malicious code and viruses.

These tools use Flash player which is bundled as part of the exe, so the user should not have to install the player from the Macromedia site. However on some machines the user may be prompted to install the latest Flash player version.



Once installed, you can access the Maths toolkits through your Start menu at the bottom left of your Windows screen.

Go to All Programs → skoool → Mathematical Tools.

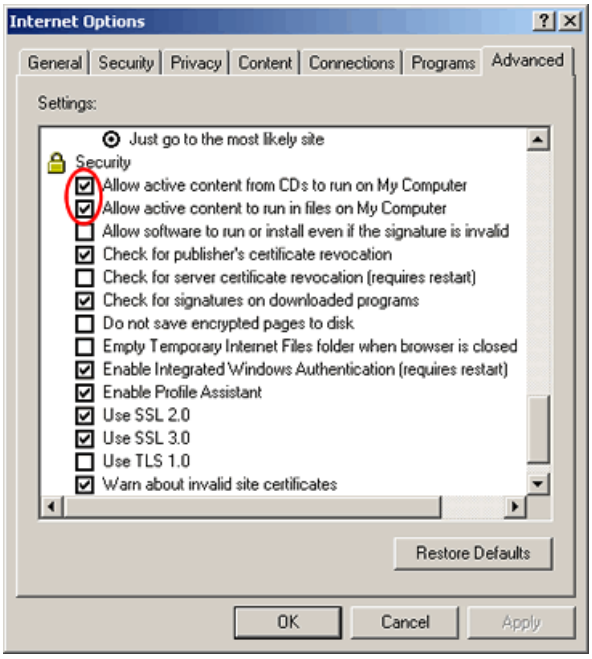
There is a more detailed guide on using the Mathematical Toolkit and Numberline tool.

These can be found inside the Mathematical toolkit or Numberline zip folder that you downloaded from the Teaching and Learning exchange.

Windows XP Service Pack 2 issues for Maths Toolkit/Numberline users

Windows XP Service Pack 2 affects any web page with "active content" running locally on your computer in Internet Explorer - the Maths Toolkit is one such page containing active content.

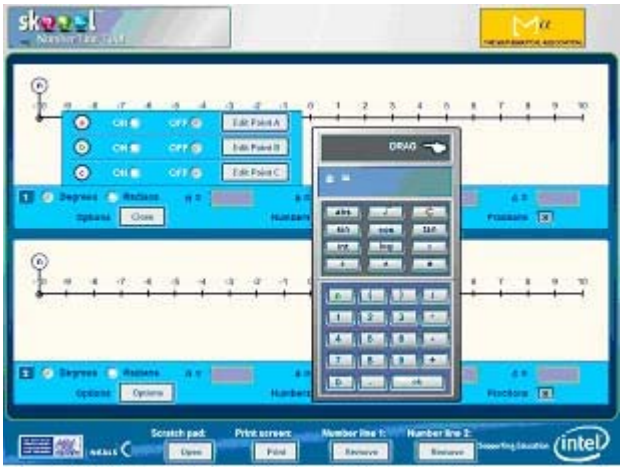
Many people provide web page information on CD, provide product documentation as web pages, or work with web pages locally before putting them online. Even very innocuous JavaScript is deemed to be active content and a user will have to agree to very worrying warning messages in order to see a page - or change their Internet Explorer security settings.



Service Pack 2 - new security settings

- Microsoft has provided new options to turn off the security on local files to let active content run, as shown above.
- To run active content without warnings, you must change a security setting in Internet Explorer:
- Open menu Tools > Internet Options > Advanced tab
- Scroll down to the Security section.
- Make sure that "Allow active content to run in files on My Computer" is checked

About the Numberline Tool



The Number line tool offers a dynamic environment in which teachers and pupils can explore numbers and relationships between them. In its simplest use, number lines can be created quickly and easily, and the display can be in decimal and/or fractional notation; the numbers can also be hidden. A point on the line, 'n', can be dragged along the number line and its exact position revealed as a decimal to a chosen number of decimal places. Further points can be positioned on the line and the environment will support pupils to make connections between related points on the line and begin to generalise about relationships using simple algebraic rules.

In collaboration with Intel and The Mathematical Association, the Mathematical Toolkit and Number line have been designed specifically to support the teaching and learning of mathematics for pupils at in Stages 2 - 5.

The tools have been developed in Macromedia Flash so that teachers and pupils can access them via the internet without needing to purchase any software.

Using the Numberline Tool

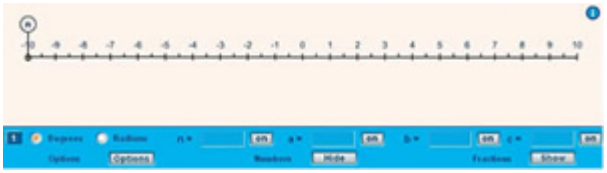
The Number line tool has been developed as an easy-to-use resource in which you and your students can quickly explore a range of statistical calculations and graphs from small scale data sets.
It is not intended to handle large data sets for which other ICT resources are more appropriate.

The environment will support a range of thinking skills which underpin rich mathematical activities and will help students to:
Understand mathematical notation
for example, how the fractions 17/20 and 0.85 are related to each other
Develop a need for mathematical conventions
for example, why we have to make a decision about what to do with the digit 4 in 23.45 if we round the number to one decimal place
Make and test conjectures
for example, predict where on the Number line a will be less than n if they are related by the equation a = n X -2
Develop a fascination with our number system
Explore independently the relationships within and between numbers
Entering a set of data Number line
When you launch the tool, you will be prompted to define your Number line by entering a minimum and maximum value. Twenty numbers will always appear on the line. You define the number of marks between each number by entering a value in scale marks.

At this stage you will want to consider the most appropriate numbers for your students and whether you are working within the range of positive and/or negative numbers or both and whether you require decimal or fractional representation.

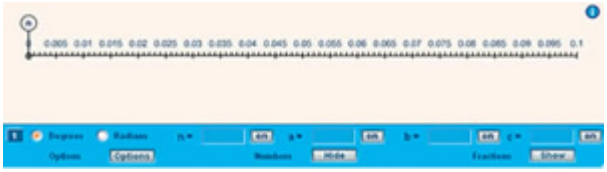
Entering these numbers:

Would give the following Number line:



Whereas, choosing

Would give this Number line.



If you select to display fractions (by clicking on the Show button next to Fractions), these will appear beneath the Number line. (You can also choose to hide the decimal Number line and only display the fractions.)

You can reveal the decimal value of n by selecting on

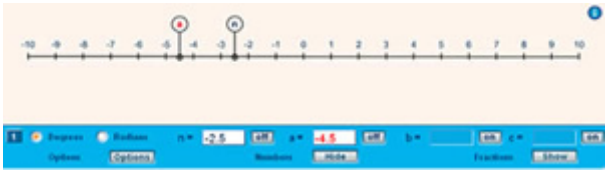
It will be displayed to the number of decimal places chosen when the Number line was created.
With your Number line created, if you now click and drag the point 'n' it will move freely along the Number line.

Using a second point to introduce variables
It is very straightforward to be able to position a second point, say a, on the Number line that is related to the movable point n.

Begin with a simple Number line with integer values, no scalemarks and an accuracy of one decimal place. Hide the value of n.
To introduce another point on the line that is dependant on the value of n, select Options and switch on one of the points (a, b or c).

You will then be able to edit the point. The calculator screen shows the rule a = n – 2 being defined.

When you select ok on the calculator screen and close the Options window, the second point will be displayed on the Number line.



Be aware that the new point may not be visible on the Number line if its value is outside of the range of numbers! You will need to drag n to try to find it! Take advantage of this feature by encouraging students to “troubleshoot” where the point has gone!

Only the point n can be dragged – you can ask students to consider why this might be the case? (a is the dependent variable and is “driven” by the point n).

The values on n and a can be revealed and hidden, as required.

There are a range of functions supported by the Number line which are:

Calculator Key	Definition	Example
neg	negation	a = neg n would mean a = -n
^	exponentiation “to the power of”	a = (n-2)^2
sqrt	square root	a = sqrt(n) would return the positive square root for positive values on n.
sin cos tan	trigonometric functions sin cosine tangent	a = sin(n) If the calculator is in Degrees, very little movement will be seen on the Number line. To explore trigonometric functions in more detail, switch to Radians.
round	Rounds a function to the nearest integer.	a = round(n)
abs	absolute Finds the “magnitude” of the function.	a = abs(n)
log	logarithm to base 10	a = log(n)

Numberline Tool troubleshooting

Occasionally it is frustrating when we cannot get ICT to do exactly what we want, so it is useful to know some of the constraints of this tool.

Defining number lines
All lines default to 20 divisions.
A maximum number of 4 digits can be input when creating a number line.
The value zero is always displayed as 0/1 on a fraction line.
Fractions are displayed in their lowest form.

Defining functions
If you want to define a function that adds or subtracts fractions, these need to entered as decimals i.e. a = n + 0.2 would represent a + n + 1/5.
If two equivalent relationships are defined, i.e. a = n*2 and b = n/0.5, point a will appear on top of point b. If you reveal the values of a and b, their equivalence can be confirmed.

Number line activities for Mathematics classrooms

Stage 4 activity: Exploring the need for a convention when rounding decimal numbers.

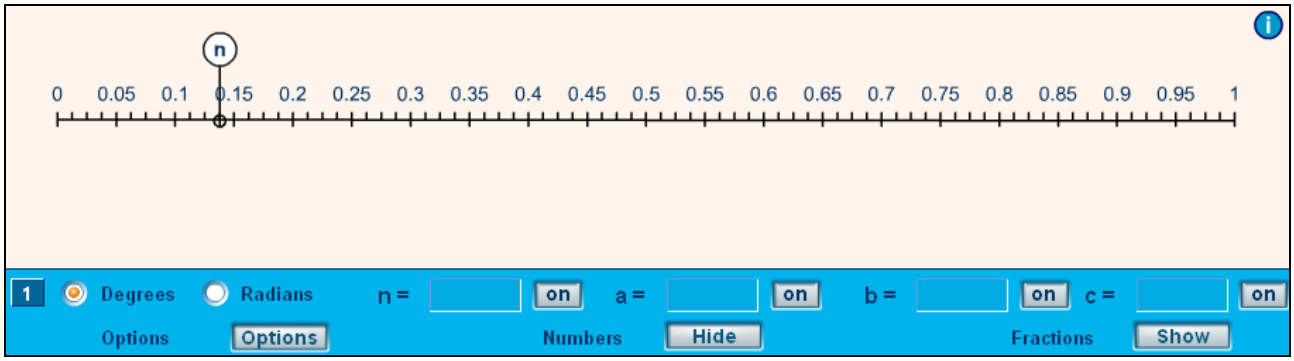
In this activity, students are supported to develop an understanding of why and how we round numbers to a given number of decimal places.

Numbers and the number system
Place value, ordering and rounding
Round positive whole numbers to the nearest 10, 100 or 1000 and decimals to the nearest whole number or one decimal place.

Preparation:
Display the *Number line* software using a data projector (and interactive whiteboard if available).
If laptops/computers are available, students could use the software to explore the effects of rounding.

Number line setup: zero to 1 with 5 scale marks and select 1 decimal place. Display the decimals only.

Additional resources: A3 laminated number lines and pens, A4 paper copies of the number line on which students could record their work.



Activity	Questions to ask students
With the value of *n* hidden, move the point *n* to about 0.14 Invite students to move *n* to different positions on the number line and follow a similar line of questioning.	Look carefully at the number line… What do you estimate the value of *n* to be? If we were going to write the value of *n* to only 1 decimal place, how could we decide what to write? Does the value of n look closer to 0.1 or 0.2?

Move *n* to a point such as 0.35 to discuss with the mathematical convention of “rounding-up”.	How are we going to decide what to write if we are rounding a number that is exactly halfway between, say 0.3 and 0.4 to 1 d.p.?
Give students the opportunity to choose some numbers of their own and round them to one decimal place, recording their work on paper.	
Reveal the value of *n* and invite a student to slowly drag the point *n* along the line. Use this feature to support students to check their previous solutions.	Look carefully at the value of *n* that is being displayed. What do you notice? Where does its value change? Why?

Stage 4/5 activity: Exploring equivalent algebraic relationships

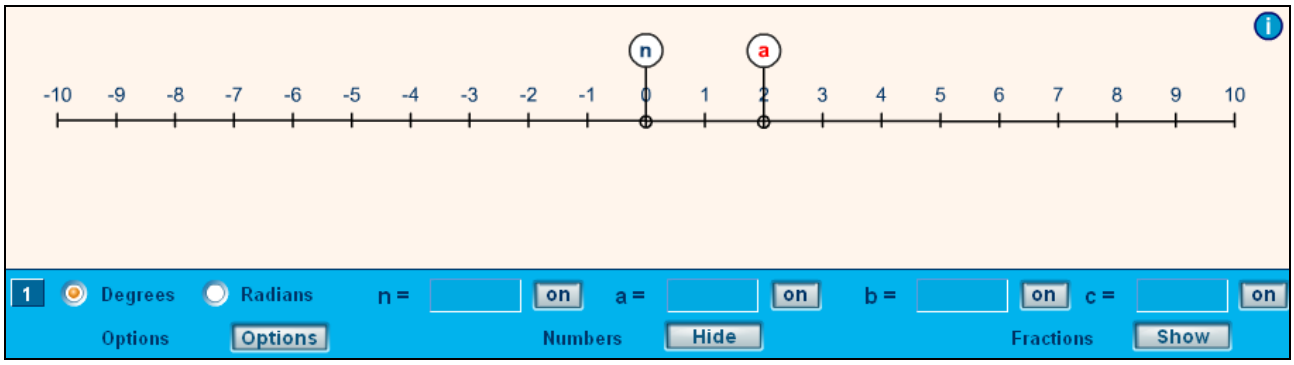
In this activity, students are supported to make conjectures about equivalent algebraic expressions that involve brackets.

Algebra
Equations, formulae and identities
Begin to distinguish between the different roles played by letter symbols in equations formulae and functions.
Simplify or transform linear expressions by collecting like terms; multiply a single term over a bracket.

Preparation:
Display the *Number line* software using a data projector (and interactive whiteboard if available).
If laptops are available, students could use the software to explore the effects of rounding.

Number line setup: -10 to 10 with no scale marks and select 2 decimal places. Display the decimals only. Away from the pupils view, define a function *a*=2*n*+2.

Additional resources: Resource sheet (see example)



Activity	Questions to ask students
Display the *Number line* tool with the relationship *a*=2*n*+2 already defined. Take several suggestions and record them for everyone to see. Choose one of the suggestions, for example, *a* = *n*+2. **Note**: Avoid the correct one at this stage! Invite a student to move *n* so that *n*=1. Discuss with students why, although the rule *a* = *n*+2 was true when *n* = 0, as it is no longer true when *n* = 1.	Would anyone like to suggest a relationship that might connect (or link) the values of *n* and *a*? If the rule a = *n*+2 was true, what would you expect the value of *a* to become if we move *n* so that it equals one? Do we think that the rule *a* = *n*+2 is true now?

Drag *n* to various positions on the line and build a table of values of *n* and *a*. For more able year 8 groups, include decimal and negative numbers. Support students to establish that the actual relationship is $a = 2n+2$ and reveal the calculator to them to how the relationship was created.	
Set the task for students, which is to substitute different vales of *n* into expressions to determine which appear to give the same result, always, sometimes and never. Choose the expressions to provoke discussion amongst students.	What do you notice about your results? Which expressions do you think could be equivalent?
Use the *Number line* tool to test the students' conjectures. Invite students to suggest pairs of expressions. Define the first expression as *a* and the second expression as *b*.	If the expressions are equivalent, what will happen as we drag *n* along the line? How can we check that they are equal if we can only see one of the points? (Either reveal the values of *a* and *b* to show they are equal of switch off *a* or *b* from the **Options** menu)
Use the *Number line* tool to confront and discuss the common misconception that $2n$ and n^2 are equivalent.	How could we use the Number line tool to prove that n^2 and $2n$ are not equivalent, although they are equal when $n = 0$ and $n = 2$?

Student task sheet: Exploring equivalent expressions

	$2(n+1)$	n^2	2n	$2n+2$	3+5n–3n-1
$n = 2$					
$n = 3$					
$n = 0$					
$n = 0.5$					
$n =$					
$n =$					