

NEWS AND VIEWS ON MATHS TEACHING FROM TEXAS INSTRUMENTS

(n)sight

WINTER 08/SPRING 09

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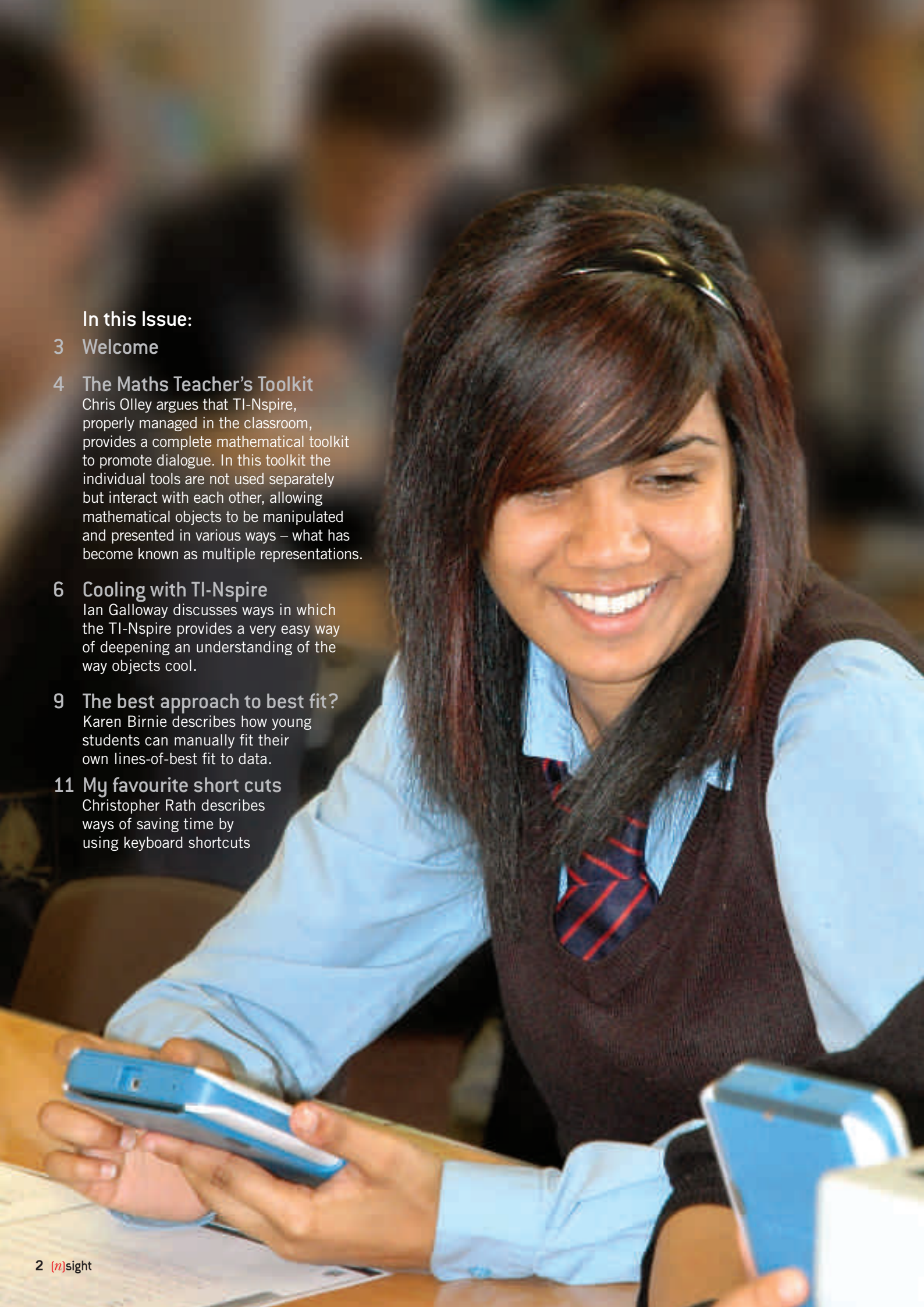
Cooling with TI-Nspire™

The Maths Teacher's Toolkit

The best approach to best fit?



Your Vision. Our Technology. Learner Success.



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Welcome...

to the first edition of (n)sight. Our aim with this publication is to share inspiring ideas from practitioners who use ICT to engage learners and improve the teaching and learning of their subject.

At TI, we have a history of commitment to improving learner opportunities by supporting the appropriate use of ICT in the classroom. We strive to develop and disseminate new teaching ideas in partnership with teaching professionals and thus to promote effective learning. Research underpins the development of our solutions.

As long-standing pioneers in the field of maths and science teaching and learning tools, our role is to help to create a platform that will inspire both the next generation of learners and the people who teach them. By providing appropriate technology and teacher-led professional development, we can help you to develop even more effective teaching and learning methods and inspire a new passion in your learners for these core subjects.

As Ofsted highlighted in their September 2008 report (*Mathematics: understanding the score*), ICT should make a positive difference in raising standards and encouraging learners to use and apply mathematics to make connections across subject areas and extend their reasoning with links to other STEM subjects. To help make that difference, we offer solutions that help practitioners to personalise learning and to inspire learners to explore and investigate their subjects, helping them to reach their potential.

We understand that ICT does not just mean technology, but curricular materials, support and professional development too. The Ofsted report* also found that “opportunities for teachers to improve their subject knowledge and subject-specific pedagogy were infrequent”. We are proud that our professional development organisation,

Teachers Teaching with Technology™ (known as T³) has been training teachers for nearly 20 years and is the largest professional development programme for maths and science teachers in the world, providing over 3,000 hours of face-to-face CPD and PGCE training every year in the UK alone. We aim to support teachers to develop a repertoire of skills and specialisms, and manage the learning experience in mathematics classrooms at every school level. Integrating ICT in an appropriate way is key to making the difference in raising standards, and support for teachers is essential for any technology enabled classroom.

A research report by the University of Chichester published in October 2008 entitled “Evaluating TI-Nspire in secondary mathematics classrooms” found that TI-Nspire was increasingly used to stimulate students to think mathematically and, in many cases, to engage and motivate strongly with mathematical structures and concepts in way that is normally not possible with traditional methods.

We offer an affordable range of learning and ICT tools that address whole class, group and individual teaching and learning to promote equal opportunities and flexible access to technology for pupils both inside and out of school. We will always work to your budget and ICT needs to provide teachers with access to personalised ICT for every pupil, as well as interactive whole-class teaching tools.

We hope that this magazine will provide you and your colleagues with opportunities to engage your learners in new ways. For more information about our technology, supporting materials, content and research, visit our website at education.ti.com/uk.



The Maths Teacher's Toolkit



Chris Olley is Director of Secondary Maths PGCE at King's College, London.

In this article **Chris Olley** argues that TI-Nspire, properly managed in the classroom, provides a complete mathematical toolkit to promote dialogue. In this toolkit the individual tools are not used separately but interact with each other, allowing mathematical objects to be manipulated and presented in various ways – what has become known as ‘multiple representations’.

A newer, sleeker toolkit

The job of teaching mathematics is about engaging learners with mathematical ideas. Sometimes we need them to learn rules and give them exercises to practise them but, most of the time, we want them to engage in a dialogue about mathematics. There are two principle ways this can happen: either the dialogue is set up between teacher and class or it is set up to take place between learners. Modern technology can provide the maths teacher with tools to set up these dialogues: tools that speak mathematics, tools that can be interrogated with mathematical questions. Using these tools, the teacher changes role: rather than being the provider of answers he or she takes on the role of the expert mediator.

Various powerful software tools exist that can provide this facility: dynamic geometry, graphing software, data logging, computer algebra systems (CAS), dynamic statistics. Over the years the maths teacher's toolkit has become more and more bulky, with ever bigger and more powerful individual tools becoming available.

It has become a major problem for the teacher to acquire the skills and level of confidence with all of these tools in order to use them confidently in the midst of classroom dialogue.

However, the advent of TI-Nspire has solved the problem of an over-bulky toolkit, providing as it does all of the major tools that a maths teacher needs in one piece of software. It still requires a little getting to grips with, but there is now only one package to learn, which will cover every possibility. Another major benefit is that TI-Nspire is equally powerful in promoting both types of dialogue, teacher-class and learner-learner. When the class level dialogue is over and the learners are engaged, they can continue to discuss the ideas between themselves, either using the TI-Nspire software on a laptop or on the TI-Nspire handheld devices.

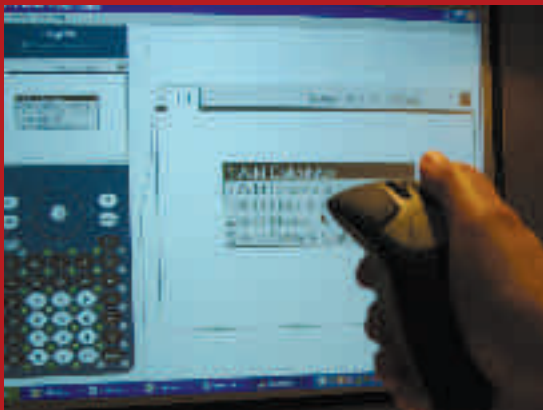


Managing your toolkit

Setting up your classroom ready to work in this way, is all-important. A class set of handheld devices will need to be stored in a box so that they can be brought out at a moment's notice. It's no good having them in a cupboard in the staffroom or at the far end of the school –that's as bad as having to book the computer room in advance and move your class there in order to use a particular software package. The handhelds have to be to hand.

Make sure there is a supply of spare AAA batteries in the box and be sure you can fit them easily – you need to anticipate problems that could crop up. Don't give out the handhelds until pupils are ready to work on their own or they will distract from the class debate.

For the teacher-learner dialogue you are most likely to be using a computer, a projector and a screen. I recommend that you have a reliable keyboard and mouse available so that you can face the class while using them. Being able to interact directly with screen objects can be very powerful and draws learners into the mathematics in an interesting, visual way. Interactive whiteboards are an increasingly common way to achieve this, but better and much cheaper solutions exist. For example, a wireless tablet or gyroscopic mouse allows the teacher to stand anywhere in the room while interacting with the software and also to give the device to learners to use at their desks. I have recently used a Logitech Air Mouse successfully in this way. However, in my opinion for routine work, the mouse and keyboard still provide the most reliable interface.



It is of course very important that the software is installed and running on the teacher's machine. One feature of TI-Nspire is that there are regular updates to the software, providing significant improvements and additions, so the Head of Maths needs a good relationship with the ICT technicians to ensure that the software is kept up-to-date. Handhelds too will need to have the latest version of the operating system installed. This is a very simple task and what a long way we have come from the days when to upgrade your graphics calculator you had to buy a new one!

The tools in the kit

Now, let's explore the toolkit metaphor a little further. A significant feature of the way that TI-Nspire is constructed is its document model. This provides pages where different applications can be used, all within one document and all interacting together.

The simplest of these applications is called *Notes*. Some teachers have begun to use presentation software such as PowerPoint to create quick aural or mental starters. This can easily be done with a *Notes* page in TI-Nspire and a second page using the *Calculator* application provides a workspace for use in the teacher-class dialogue.

Alternatively the two tools can be used side by side on the same split screen. For the main part of the lesson, it is possible to move seamlessly on without having to load different software. And, most powerfully, data entered on those first pages can be automatically used on other pages, perhaps in the form of a spreadsheet (the *Lists & Spreadsheets* application), perhaps in the form of a function graph (the *Graphs & Geometry* application) or perhaps as a statistical plot (the *Data & Statistics* application).

An example of multiple representations

The screenshots here show a simple example of several tools being used within a single TI-Nspire document that has been set up in the form of a game.

- 1 On the first page of the document the *Notes* and *Calculator* applications are used to give instructions and to allow a function to be defined in algebraic terms.
- 2 The second page has another representation of the function, with a spreadsheet showing particular numerical values in the function's domain and range.
- 3 The *Data & Statistics* application on the last page provides graphical representations of the function: a scatterplot of the particular values from the spreadsheet and also the graph of the function.



1



2



3

Conclusion

This article has barely scratched the surface of the functionality of the TI-Nspire software. There is a growing body of support materials to show you what the software can do, not least the other articles in this magazine. The purpose here has been to see TI-Nspire software running on a computer as something that can be used by the teacher in many ways throughout the lesson. It also allows learners to explore ideas on their own, using exactly the same software on their handheld device. Soon this technology will become the natural way of operating in the classroom for everyone as teachers begin to appreciate the power and versatility of this mathematical toolkit.

Cooling

with TI-Nspire



Ian Galloway is Deputy Director of the Science Learning Centre South East, at the University of Southampton.

The entire universe is busy redistributing its thermal energy and will reach a uniform temperature of about 4°K about a googol years from now. This is because all processes result in the creation of entropy, order to disorder, and so the universe is steadily unwinding. Clearly cooling is of immense importance to our survival, although much may happen over the next googol years!

More importantly to us in our small part of the universe on planet earth, life is busy changing disorder to order, but the net result is the same, a steady increase of entropy, which we continually fight against. We wear clothes, insulate our houses and seek more efficient ways of burning fuels to drive engines. Cooling is therefore still a very important process, not least because all biological systems only function within certain temperature ranges. Yet, we know little about how cooling takes place beyond having a good physical understanding of the mechanisms: radiation, conduction and convection.

Most learners have a good intuitive grasp of the notion that cooling is more rapid the greater the temperature difference between the cooling object and its surroundings: *or the rate of cooling is proportional to the temperature excess over the environment.*

But it is not generally realised that Newton's law only holds when the body is in a constant stream of air and for this reason alone it is worthwhile studying cooling in the school classroom.

Forensic work

Imagine a murder has been committed and the body is cooling. Crime Scene Investigator Grissom measures the temperature of the body as 25.5°C while the room temperature is 22.2°C. One hour later, the body's temperature is 24.2 C. Normal body temperature is 36.8°C. Can Grissom find out when the murder occurred?

With TI-Nspire this is easy. The constant a in our case is 22.2. When t is zero, Grissom's first measurement is 25.5 so $a + b = 25.5$ and $b = 3.3$. The constant c must be less than 1 but will depend on the size of the body, the clothing etc. Let's guess it is 0.8 and refine it later.

So on a Graphs & Geometry page we can enter the function $22.2 + 3.3 * 0.8^x$. **figure 1**

The x-axis represents time and the y-axis represents temperature so window settings need to be changed so that we will be able to find when the temperature was 36.8°.

Newton's Law of Cooling

$$\text{Temperature} = a + bc^t$$

where:

- a** is the temperature of the surroundings
- b** is the initial excess temperature
- c** is a constant dependent on the physical characteristics of the body
- t** is the time elapsed

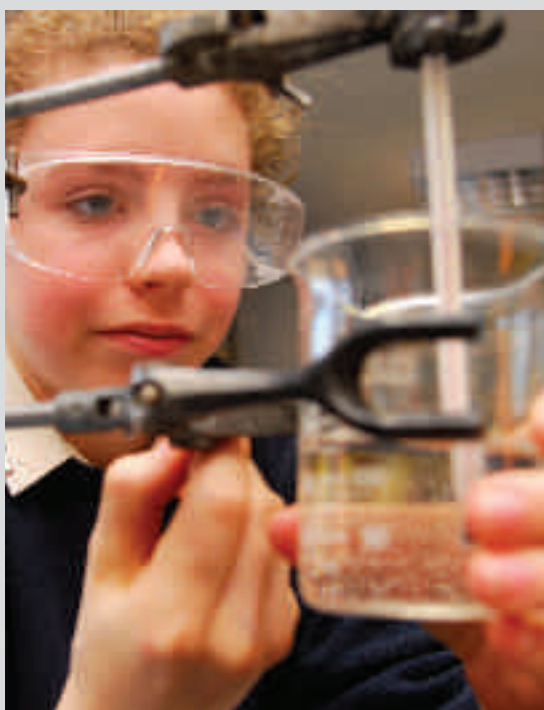


Now, to put a movable point on the graph, press $\left[\text{menu} \right] <6:\text{Points and lines}> <2:\text{Point on}>$. Grab the point and move it very close to the elapsed time of 1. **figure 2**

If you move the cursor over the x-coordinate and press $\left[\text{enter} \right]$ twice, you are able to edit the coordinate and make it exactly 1. The point moves and the corresponding y-coordinate is calculated: 24.84. Grissom recorded 24.2° after 1 hour, so the constant c needs adjusting in the function until the y coordinate is close to 24.2.

By trial and error, c can be found to be 0.61. Now to find the time corresponding to 36.8° , slide the point along the curve and/or edit its y coordinate to make it 36.8. **figure 3**

The time of the murder was 3 hours before Grissom arrived.



Modeling a cooling corpse!

This can easily be set up in the classroom with a beaker of luke-warm water representing the body. Ask the class to find out when the body 'died', i.e. when did the water have a temperature of 36.8°C ?

Learners will have to record the temperature of the water (and the room) and some time later they will have to take the water's temperature again. They can then follow through the procedure above, first determining the value of c and then estimating the time of the murder.

Complications arise if the external temperature changes while the body is cooling. In any case, it really is an assumption to assume that the rate of cooling is exponential as, in general, it will not be. Comparisons could be made between a beaker undergoing forced cooling (a fan) and another that is simply cooling by convection and radiation.

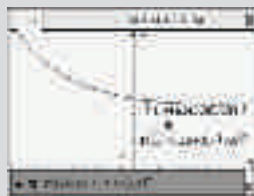


figure 1



figure 2



figure 3



Checking Newton's Law

It is possible to use TI-Nspire to collect data from a cooling body (a temperature probe) and explore how well it fits an exponential model. Use either an EasyTemp probe with mini USB or the Vernier EasyLink connector and a temperature probe with an ordinary telephone style connector. When you insert the EasyTemp probe directly into a TI-Nspire handheld, a control console opens up automatically.

Clicking on the start button will, by default, launch data collection for 180 seconds at one sample per second and this data can be collected to determine how well they fit to an exponential function. The probe should be put into hot water (about 85°C if possible, health and safety permitting) and wiped dry before starting data collection. It is important to wave the probe gently in the air for the full three minutes while the data is being collected. This ensures forced cooling and a good fit to an exponential will follow. **figure 4**



figure 4



figure 5



figure 6

The same procedure as above can be followed to find the constants of a general exponential function that fits the data. In the example shown, displaying the data in a spreadsheet enabled the start temperature (85.6°C) and the room temperature (17.5°C) to be determined. The constant c for the Easy Temp probe was found to be very sensitive: it was 0.981, nearly 1.0! **figure 5**

Alternatively the TI-Nspire handheld can be asked to carry out an exponential-regression calculation. Given the uncertainties, the fit of the exponential is very good and one need go no further to be convinced that the change of temperature is exponential. This of course confirms Newton's Law of Cooling: *the rate of cooling is proportional to the excess temperature over the surroundings.* **figure 6**



Further work

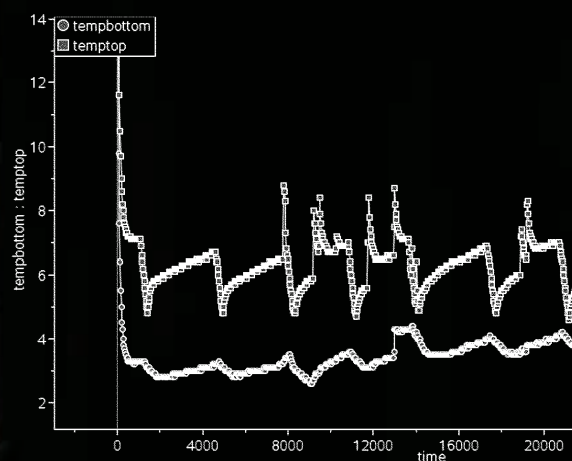
The single temperature probe can be used to investigate cooling without forcing, to see if the relationship between excess temperature and rate of cooling still holds.

Teachers and learners at workshops run at my centre, have enjoyed investigating the Mpemba effect, where it is claimed that hot water will freeze more quickly than cooler water. This kept a whole group busy for the entire day on a topic that at first glance does not look particularly inspiring.

There is no accepted scientific view of the Mpemba effect so this makes the investigation a real one.

Another interesting investigation can be carried out into how the refrigerator works. Use two temperature probes attached to two handhelds. Locate one probe at the bottom of the refrigerator and one at the top and set data collection for a few hours. The two handhelds can then be linked and the two datasets combined into a single spreadsheet. Alternatively you can use a single TI-84 and CBL2 with 2 temperature probes – the data is easily copied and pasted directly from TI Connect into the TI-Nspire software spreadsheet.

Below is a typical data set (displayed using TI-Nspire software) from a refrigerator over about seven hours. It reveals a number of interesting features: lower temperatures at the bottom, the point at which the thermostat cuts in, times when the door is opened, the temperature range. While the top warms the bottom continues to cool for a while, why is this?



The simple ubiquitous phenomenon of cooling can be a truly inspirational topic of investigation and the TI-Nspire is a superb tool for manipulating and displaying data, making observations and asking and answering questions.

< Sir Eduardo Paolozzi's statue of Newton (after William Blake) outside the British Library.



Best Fit

What's best for you?



Karen Birnie is Principal Teacher of Maths, Aboyne Academy, Aberdeenshire

It is common to see mathematical software automatically fit a linear regression line to a scatterplot but is that really what we want learners to do? Certainly, for younger secondary learners, it is more appropriate to ask them to draw their own line of best fit to a scatterplot by eye and then to use their line for interpolation. More able and older learners should also be able to work out the equation of their line of best fit.

The TI-Nspire Data & Statistics application allows the user to draw a movable line on a scatterplot and then to compare that line to a fitted linear regression. An alternative approach uses the *Graphs & Geometry* application: after creating a scatterplot, a movable line can be drawn, a point can be slid along it and its co-ordinates displayed. By finding the co-ordinates of two points on the line, learners can then calculate their line's equation and check their answers by asking for the technology to display the equation of the line. They can then use their line to predict one value, given the other.

If you follow through the guidelines below it will enable you to see for yourself these two different ways of fitting a line of best fit to data. As you do this, you will be able to assess which of the two methods would be more appropriate for your learners. You may, indeed feel that using both methods is most likely to help their understanding. The guidelines help you to create a .tns file that you may subsequently want to distribute for your learners to use. Almost certainly you will not want learners to follow through the guidelines themselves but, hopefully, they will provide ideas for you to choose from, suitably adapted for your own class.



Getting started

To open a new document, press <6:New Document>.

For the first page use a *Notes* application. Then use to insert three more pages, choosing *Lists & Spreadsheet* for the second, *Data & Statistics* for the third and *Graphs & Geometry* for the final page.

Name and save the document by pressing <1:File> <4:Save As...> and, throughout its creation, remember to save the document with .

Return to page 1.1. Type a title and introduction, using <3:Format> if you wish. **figure 1**

Move to page 1.2— a *Lists & Spreadsheets* page. Give columns A and B appropriate labels and then enter your chosen data. For this demonstration, I have used hypothetical French and Spanish marks of 20 learners. **figure 2**

Data & Statistics

Move to page 1.3 for *Data & Statistics*. Create a scatterplot by clicking the bottom centre of the screen to add the independent variable and then clicking the left centre of the screen to add the dependent variable.

To add a movable line to the scatterplot, press <4:Analyze> <2:Add Movable Line>.

The line can be adjusted horizontally or vertically by grabbing it near the centre. The line's slope can be adjusted by grabbing it near its ends. Notice that the equation of the movable line is also shown. **figure 3**

If you wish, the residual squares can be added to the plot using <4:Analyze> <7:Residuals> <1:Show Residual Squares>. This displays the sum of the squares and learners can be challenged to manipulate their movable line to minimise the sum. **figure 4**

A further option is to fit the line of linear regression to the scatterplot using <4:Analyze> <6:Regression> <1:Show Linear>. This allows you to compare your movable line with the regression line.



figure 1



figure 2

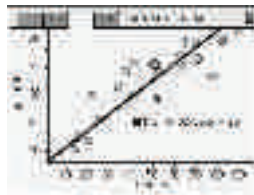


figure 3

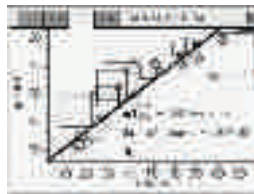


figure 4



figure 5

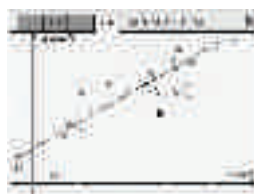


figure 6

Graphs & Geometry

Now compare what was essentially a statistical approach to a geometrical one on page 1.4. Choose a scattergraph: <3:Graph Type> <4:Scatterplot> and select the x- and y-variables.

Choose window settings in order to see the origin and the axes: <4:Window> <1:Window Settings>.

Hide the entry line using .

An unwanted label naming the co-ordinate pair is shown, so select it and hide it by pressing <2:Hide/Show>.

If you wish, edit the x and y labels on the axes and, to distinguish the data points from points you will add later, change them to crosses using <1:Actions> <4:Attributes>. **figure 5**

Now you can add a moveable line. Press <6:Points & Lines> <4:Line>.

You need to fix an initial point and “pull out” the line until it appears to fit the data well. (Hint: put the fixed point to the left of the y-axis.)

Now construct a movable point on the line <6:Points & Lines> <2:Point On>.

Show the coordinates of this last point using <1:Actions> <7:Coordinates and Equations>. If you wish you can reduce the number of decimal places displayed by selecting one coordinate, pressing and then . **figure 6**

Now it is possible to grab and slide the movable point along the line enabling learners to note two pairs of coordinates and work out the equation of their line of best fit. Learners can then check their answer by displaying the equation of the line: select the line, then press <6:Coordinates and Equations>. This avoids the nightmare scenario of the teacher having to check 30 individual solutions!

Summary

By constructing a scatterplot, either with *Data & Statistics* or with *Graphs & Geometry*, TI-Nspire enables learners to draw a line that seems to them to be the best fit for the data points. For more advanced learners, the *Data & Statistics* application allows them to use residual squares to refine their best fit line and to superimpose a calculated linear regression line. However, with *Graphs & Geometry*, younger learners are able to gather sufficient information to allow them to calculate the equation of their own line, to use it to answer interpolation questions and to assess their own solutions by checking their answers.

Which approach to best fit is best for your learners?

My favourite shortcuts



Christopher Rath works as Education Technology Support Co-ordinator with Texas Instruments and has been lucky enough to learn from an array of TI-Nspire beginners and improvers alike.

Just like a PC, TI-Nspire has a range of keyboard shortcuts that can be used for common tasks such as copying: and pasting: . We asked Christopher to pick out some of his favourite but less-familiar shortcuts that he has uncovered so far. Here is his list - do let us know if you have favourites that are not here.

Shortcut	Where can I use it?	What does it do?
	Graphs & Geometry	Hides/shows the function entry line. Creates more space for axes and graphs.
	All applications	Inserts a new page after the current one.
	All applications	Selects an entire application on a split or full page in order to copy, move or delete it. Very useful when wanting to reduce the number of applications being used on a page.
	Notes	Adds a maths expression box. The expression will be correctly formatted and can be evaluated using <4:Actions>.
	Lists & Spreadsheet	Re-calculates outputs from formulae. Useful when working with random numbers.
	Graphs & Geometry	Inserts a function table next to the graph.
 	My Documents Lists & Spreadsheet etc.	These are like Home, End, Page Up and Page Down on a PC. You can move quickly up or down a list of documents or a spreadsheet column.

First Steps with TI-Nspire™

Seven Introductory Tutorials for Teachers

This 40-page book was written by T³ specifically for new users of the TI-Nspire handheld or software. It is a comprehensive introduction to all the basic procedures needed to use the technology effectively in the classroom.



- 1 **TI-Nspire Documents**
– the basic ideas
 - 2 **The Calculator application:**
arithmetic and algebra
 - 3 **The Notes application**
 - 4 **Graphing**
 - 5 **Interactive geometry**
 - 6 **Lists and spreadsheets**
 - 7 **One- and two-variable statistics**
- Appendix Multiple representations**

Co-written and edited by Barrie Galpin, this resource has been very positively reviewed...

“Every maths department embarking on TI-Nspire should have copies of this book available for its staff.”

Email t3@ti.com to request your paper copy or download the PDF from the Online Resources page at education.ti.com/uk.



What TI technology is available?

Our range of technology for schools includes software and handheld devices designed specifically for education, classroom networking tools, graphics calculators and a variety of sensors and probes for data logging activities (to meet the STEM agenda). Our software is designed to integrate with existing classroom projection systems to enhance the learning and teaching experience.

What services do we offer?

T³ (Teachers Teaching with Technology™)

– a teacher organisation devoted to professional development and activity creation designed around UK curricula.

Over the past 17 years, T³ has been committed to delivering professional development for maths and science teachers to support their appropriate use of TI technology in the classroom. T³ makes it possible for teachers to get together with others to explore the technology. Because all of the trainers teach themselves, the course is run from a perspective of effective classroom practices.

For eight or more teachers, we can offer on-site CPD at your establishment, free of charge. Our education consultant will work with you beforehand to understand your objectives and help tailor the session to your needs. We welcome maths and science teachers and encourage you to share your session with other schools in your area.

- **TI-Nspire™** – the award-winning handheld and software ICT platform for maths and science with additional options:
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 - **TI-Nspire Navigator™** System - the wireless classroom network for TI-Nspire
 - **TI Connect-to-Class™** - document and file sharing for TI-Nspire handhelds
- The **TI-84 Plus™** and **TI-83 Plus™** family of graphics calculators
- **TI-SmartView™** - the software emulator of the TI-84 Plus graphics calculator
- **CBL 2™**, **CBR 2™**, **EasyTemp™** and **EasyData™** with support for more than 30 probes and sensors.
- **Cabri Junior** and a host of other APPS available on the TI-84 handheld device
- **TI-Nspire CAS**, **TI-89 Titanium** and **Voyage™ 200**, our CAS (Computer Algebra Software) solutions.

We also run a series of local workshops around the country during the summer term. For further details, including dates and venues, please visit our website, or email t3@ti.com

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With every purchase of a TI-Nspire handheld device or graphics calculator, you could obtain free TI technology – from as little as purchases of 20 devices.

For more information, visit education.ti.com/uk

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