TI-Time: Winter 2006/7

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TI-SmartView has been short-listed for a BETT 2007 Award

– find out more about this ground-breaking piece of computer software on page 14

About this edition

Welcome to TI-Time, a collection of articles and news items. It is published twice each year and is designed to be of interest to all those using (or thinking of using) Texas Instruments technology in schools and colleges.

The theme of this edition is how personalised handheld technology can provide cost-effective, user-friendly support for teaching in both maths and science. With data logging now a requirement for science teaching at KS3 it often makes good sense for equipment and expertise to be shared between the two departments. There are many low cost but high quality sensors available which, when used in conjunction with TI technology, can provide readily accessible ways of collecting data.

On page 5 you will find an article that describes current developments in the use of personalised handheld technology in maths and science departments. You will also find articles describing the use of data logging to teach the concepts of density (and how it varies with temperature), sound (relating pitch with frequency and loudness with amplitude) and electrical resistance (relating it to voltage and variation with temperature). The articles also show how, with a little understanding of the calculator's standard data-handling facilities, teachers have the ability to use the collected data exactly as they wish.

At Texas Instruments we believe that our hand-held technology can change for the better the way that mathematics and science are taught and learned. Now that is a big, bold claim, so on pages 2 and 3 we have set out the philosophy that drives our product development and support. As well as that there is a useful piece by Chris Olley summarising the current regulations on the use of calculators in examinations. You'll find two more short articles, another competition and latest details of the support and training available through T^3. So it's certainly a bumper edition that we hope will be of interest and use to you and your colleagues. We'd very much welcome any comments or suggestions. It is available both in printed form and electronically on the TI UK website: http://education.ti.com/uk. If you would like extra paper copies for your departmental colleagues, please do let us know.

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Making ICT count every day

Spencer Williams

Spencer Williams

Spencer Williams has worked in educational ICT for over 12 years and now works for the education division of Texas Instruments. Here he sets out the guiding principles that have made the company one of the world's leading providers of classroom ICT and is still developing exciting new technologies for the future.

Firstly, a brief history of TI: the company was founded in Texas 75 years ago and has quite literally changed the world, from revolutionizing oil exploration in the 1930s to creating the foundation for modern electronics in the 1950s, including the creation of the first commercial silicon transistor and the invention of the integrated circuit.

In the mid 1980s a division was formed to develop Educational and Productivity Solutions, with a big emphasis on working hand-in-hand with teachers to develop graphics calculators. The company is still based in Dallas but has a large presence in Europe and elsewhere. TI has had a UK office for 50 years and has been active in UK education for the last 15 years.

Texas Instruments believes that ICT must make a positive difference in raising standards and encouraging students to be successful. To make that difference, we offer solutions that help educators tailor education to individual needs, interests and aptitude so as to help every young person reach his or her potential.

We offer an affordable range of learning and ICT tools that address whole class, group and individual teaching to enable equal opportunities and flexible access to technology for pupils both inside and out of school.

Not every school has the same level of funding and ICT infrastructure. We recognize and work within your budget to ensure that teachers can still have access to personalised handheld learning platforms for every pupil, as well as interactive whole-class teaching tools.

We understand that ICT does not just mean product, but materials, training and support. Integrating ICT in a useful, pedagogically appropriate way is key to making the difference in raising standards. Support for teachers is therefore a cornerstone of every technology enabled classroom. Our teacher's professional development organisation, Teachers Teaching with Technology™ (known as T³) has been training teachers for over 15 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 Continuing Professional Develepment and PGCE training every year in the UK. We aim to support as many teachers as possible, to have a repertoire of skills and specialisms and be able to manage the learning experience in mathematics classrooms at every school level.

We work closely with practising teachers in the design of our technology to provide more interactive, visual experiences, motivating pupils to enjoy, understand and be successful in maths and science, subjects which can be both fulfilling and potentially important to their future career options and success in life.

Texas Instruments is an education technology leader, working with educators throughout the world in developing classroom technology. Not only do we work with educators in the design of our products, but also the professional development services and support materials that enrich the classroom learning experience at every level. Our core competence is mathematics education and data logging in maths and science at all levels of the curriculum.

We are in agreement with the Department for Education and Skills response, made to the Smith enquiry report "Making Mathematics Count":

"Mathematics is of central importance to modern society. It provides the language and analytical tools underpinning much of our scientific and industrial research and development. Mathematical concepts, models and techniques are also key to many vital areas of the knowledge economy, including the finance and ICT industries. Mathematics is crucially important, too, for the employment opportunities and achievements of individual citizens."

The current shortage in the UK of young people continuing the study of mathematics beyond GCSE level is of national concern for industry and the future of the British workforce in our global knowledge economy. Texas Instruments is therefore working in maths and science educational partnerships to continuously develop our offering and services in the UK.

Making ICT and mathematics count every day:

for your classroom:

- With over 15 years' experience in the UK education market, TI continues to develop innovative maths products which are compatible with today's classroom infrastructure
- We take the views of educators seriously in developing products for the classroom
- What technology is available for your classroom? Our product range includes personalised handheld devices designed specifically for KS3 levels, wireless classroom networks, graphics calculators for KS4 and A-level students and a variety of options with sensors, probes and software to suit teaching and learning using the interactive whiteboard:
  - TI-SmartView™ – shortlisted for a BETT Award in 2007
  - TI-84 Plus™ and TI-84 Plus Silver Edition™
  - TI-73™ and TI-Navigator™ for KS2 and 3
  - Data Logging Suite – CBL 2™, CBR 2™, EasyTemp™ and EasyData™
  - Cabri Junior and a host of other APPS available on the handheld device
  - CAS (Computer Algebra Software) solutions such as TI-89 Titanium, Voyage™ 200 and Derive™
  - We will be launching exciting and inspiring new ICT technology in 2007 - watch this space!

for your school:

- Workshop Loan products – support for your CPD activities and evaluation to test suitability of TI technology for your classroom (see more details below)
- Volume Purchase Programme – provides free TI equipment for volume purchasers
- We work with educational suppliers who support school purchases and provide advice
- T^3 – organisation specifically devoted to training and activity development designed around UK curriculum
- Experience shows that students value the opportunity to work with personalised technology and the subject specific nature of these tools makes them less prone to misuse.

for your students:

Maths Scholarships

- The Texas Instruments Maths Scholarship provides £1,300 for two students starting a maths-related degree. The scheme is promoted every year to all UK sixth form colleges or schools with a sixth form. From the hundreds of entries received, around 30 students are invited to an open day at Texas Instrument, where they take part in group mathematical activities. Two students are selected on the basis of their mathematical skills and team-working abilities and win the scholarship which helps to support them financially during their first year of study.
- Real world maths – data-logging activities allow data to be collected, manipulated and incorporated into students' work while still respecting the mathematical process

We have created an exclusive set of educational activities based on the crime investigation television series "Numb3rs", which uses the strapline "We all use maths every day". These activities promote the many uses of mathematics and support maths teaching. They have been developed by teachers especially for students at KS4 and A-level and are based on the mathematics presented in each episode of the second series.

Numb3rs activities are based on real FBI cases. Mathematics consultants work with the Numb3rs production team throughout production to ensure that the mathematics used to help analyse and solve crimes is real and accurate. Activities based on each episode are downloadable from our website.

The Texas Instruments Workshop Loan Programme

The Texas Instruments Workshop Loan Programme Using our free Workshop Loan Programme, you can find out more about how our educational technology can enhance your students' learning. It's an ideal way for you to get TI products for teacher workshops or in-service training, or to borrow individual calculators so that you and the other teachers in your department can evaluate them. Loans are available for up to a 3 week period. If you would like posters, overhead transparencies and other literature to distribute to workshop participants then please just ask!

To reserve your Workshop Loan, simply complete the online form on the Teachers section of our website or contact our Customer Service Centre on 020 8230 3184.

Can you or can't you use them in exams?

Chris Olley

Chris Olley

Can students use a graphics calculator in public exams? This is a question now so surrounded with myth and folklore that it has been hard to get straight answers out of anyone. Chris Olley reports on the current position.

First we have to be clear that there are some papers, such as the P1 papers at A-level, where no calculators at all are allowed. However, there are other papers where some calculators can be used. But which calculators are restricted?

Happily, in January this year the situation at A-level changed. Previously on one paper, scientific calculators were allowed but all graphics calculators were ruled out. A statement of the position now is available at www.qca.org.uk/12041_1727.html: if an exam paper allows calculator use, then *any permitted* calculator is allowed. So, what graphics calculators are permitted?

The existence of the Joint Council for Qualifications (JCQ) means we now have the following very clear statement.

Calculators must not:

- be designed or adapted to offer any of these facilities:
  - language translators;
  - symbolic algebra manipulation;
  - symbolic differentiation or integration;
  - communication with other machines or the internet;
- be borrowed from another candidate during an examination for any reason; (An invigilator may give a candidate a replacement calculator.)
- have retrievable information stored in them – this includes: -
  - databanks
  - dictionaries
  - mathematical formulas
  - text

(Source: http://www.jcq.org.uk/ and search for: instructions for conducting examinations).

So, we can use any graphics calculator, so long as it does not contain a Computer Algebra System (CAS). This means that the TI-89 and Voyage 200 are not allowed in exams, although they remain excellent tools for classroom use.

We can use a TI-80, TI-82 or basic TI-83 since they cannot store non-volatile data and just need to be reset before the examination.

The TI-83 Plus and TI-84 Plus are able to have loaded software applications (Apps) some of which break the JCQ rules. Examples of unacceptable Apps are: Organizer, Polynomial Root Finder, Inequality Graphing, Conic Graphing and Area Formulas. But these calculators can be used if they have the offending Apps removed and are reset before the exam.

Summary

TI-80, TI-82, basic TI-83	✓	Reset before exam
TI-83 Plus, TI-84 Plus	✓	Remove some Apps and reset
TI-89, Voyage 200	✗	

So, here's my advice

Give your students the full advantage of the power of graphics calculators in their exams. The maths department should have its own set of TI-84s for classroom use. These should have any offending Apps removed by the department before the exams. During the exams, students can ask to have a calculator loaned to them for those questions where it would be particularly useful. When finished, the invigilator can collect it (and reset it) before making it available to another student. In this way the full cohort can be accommodated from relatively few machines. This procedure has been used very successfully for many years in the inner-city comprehensive where I was previously the Head of Maths.

Personalised hand-held technology in mathematics and science departments

Adrian Oldknow, University of Chichester

Adrian Oldknow

Maths and science have much in common as subjects in secondary schools. They are both:

- core subjects;
- strands of the Secondary National Strategy;
- key to concerns about supply of skilled people (STEM);
- shortage subjects for teacher recruitment and retention;
- continually subject to change in curriculum and assessment;
- strongly reliant on ICT in their practical application outside education;
- concerned with making sense of the world around us and
- essential in making predictions about the future.

In some countries there is little distinction between subjects – many Scandinavian teachers teach both maths and physical science. In others, such as France, there is a very strong distinction where maths is seen as an abstract and cerebral activity divorced from practical work. Britain has usually taken a more pragmatic approach – based, maybe, on its track-record of leadership in engineering and technology.

In practice, we see very little cross-subject collaboration at the secondary school level for all sorts of good reasons such as:

- the way National Curricula are presented in terms of discrete subjects;
- the way both subjects are usually taught in sets (which differ for maths and science);
- pressures of time and staffing;

- little incentive for teachers to plan work together.

This article attempts to provide some good reasons for cross-subject collaboration, together with some examples of activities already undertaken, ongoing and future opportunities.

First though, we should recognise that there are some major disparities between maths and science. In contrast to maths:

- science is recognised as being of national importance by powerful bodies such as the Royal Society, the House of Lords and the Department of Trade and Industry;
- science has obvious economic links with major companies, particularly pharmaceuticals, as well as other benefactors such as Salters and Wellcome;
- science is recognised as a subject which is continually changing - most science teachers belong to their subject professional association, the ASE;
- science is usually taught in purpose-designed and well-equipped accommodation.

The main rationale for joint planning by maths and science departments is for the benefit of the students, so that they appreciate opportunities for collaborative approaches which make both subjects more real, relevant, interesting and exciting. Experience in schools which adopt this approach is that this appreciation

Personalised hand-held technology in mathematics and science departments

continued

applies equally to teachers. A problem shared by both departments is how to provide hands-on access to ICT by students during normal lessons in the rooms in which they are normally taught. This is where personalised access to hand-held technology, such as graphics calculators, data-loggers and sensors has a major role to play. We'll just look at a few examples of this in practice.

The report of a project using handheld technology in schools in Hampshire and Portsmouth: `*Data capture and modelling in mathematics and science*' is available at: http://vtc.ngfl.gov.uk/uploads/application/datacapture-16796.pdf. The equipment and the experiments are as current as ever – although details such as models and prices have changed a little. The two sensors used most frequently in the schools were the CBR 2 and a temperature probe for use with the CBL 2. The latest graphic calculators have USB ports and the CBR 2 and EasyTemp probes connect directly to the USB port of the graphic calculator or PC, without need for an interface such as the CBL 2.

This photograph shows a maths and science teacher working together in a science lab using a CBR 2 with a TI-84 Plus graphics calculator under a simple spring-mass experiment, obviously delighted with the sine-wave drawn from the data which they have captured! This is a simple experiment which can be carried out anywhere – with no health and safety implications. In science, it can be used to support discussions about velocity, acceleration, forces and energy, relating it to explanations, such as how a spring works. In maths it can support exploration of the sine function and its transformation, e.g. using the amplitude and wave-length to fit a mathematical model of the type $h = a + b.\sin(ct + d)$ to the data. Technically, the data can be transferred easily between graphic calculators or uploaded to a PC so that they can be accessed by teachers and students anywhere, anytime.

The T^3 CPD programme is an ideal vehicle to support collaborative work. The maths and science advisory teachers in Barking & Dagenham ran a 2-day T^3 course for maths and science teachers from each of their eight secondary schools. The schools borrowed equipment from the TI Workshop Loan Programme to use between the two days of the course. The Science Learning Centre SE in Southampton has piloted a successful 1 day T^3 course for 20 maths and science teachers: SE106 Data Collection and Graphing Skills for Maths and Science Teachers. A key issue in both of these events was the discussion about science as a source of data for a range of different models and their graphs – such as distance-time graphs (linear, quadratic, periodic…), cooling curves (exponential), growth-and-decay models etc.

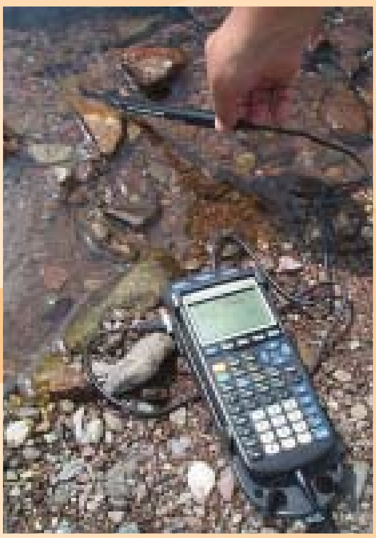
There is a current Microsoft/TDA `Partners in Learning' project in Hampshire called: `Innovative uses of ICT to facilitate collaborative approaches to teaching and learning in secondary mathematics, science, DT and related subjects.' This brings together maths, science and Design Technology teachers from five secondary schools, as well as colleagues from other areas such as PE/Sport and Art. The project focuses on collaborative planning of activities involving students with hands-on use of ICT. One example is the use of heart-rate monitors in PE with the data being used in both maths and science lessons.

So, inter-subject collaboration can be achieved – T^3 training can facilitate it and the TI Workshop Loan Programme allows schools to `try before they buy'.

What does the future hold? Well the National Science Centre in York is developing a three-day residential course for science teachers: `NAT51 : Developing Numerate Scientists'. From January, The Bowland Trust and DfES are supporting the development of 20-25 case studies of open-ended problem-solving, realistic, cross-curricular tasks for KS3 maths with an associated CPD programme – so watch out for some maths/science linked activities. In particular `forensics' is often used as a theme in secondary-school science – and it is one which opens many opportunities for maths and science collaboration, supported by handheld technology.

Distance Time with the CBR 2

Many school maths departments have class sets of graphics calculators and some also use the ultrasonic motion sensor known as the Calculator Based Ranger™ (CBR 2). This is brilliant for teaching concepts of distance, time and velocity and there were two related articles in last summer's edition of TI-Time. You can download that edition from http://education.ti.com/uk.



Probing further

There is a huge range of probes that connect to TI handheld technology to make data gathering in the field (or in the stream!) very easy indeed. The picture on the left shows a water-quality experiment being carried out in a Cumbrian beck. The probe in the water is a Dissolved Oxygen Sensor and is supplied by Vernier. (see www.vernier.com).

How science works

Ian Galloway

Ian Galloway

In this article Ian Galloway describes two investigations that help children develop their understanding of two key concepts: density and electrical resistance.

In the UK, new GCSEs in science place great emphasis on "How Science Works". They focus on examining evidence in order to answer questions such as "how do they know that?" In principle this should mean that science departments up and down the country will be bringing out their data-logging kit to assist children in collecting data and making sense of it.

In practice, unless there is a culture of data-logging within the school, the kit is likely to be left where it is, as old and tested analogue methods prevail. There are three possible reasons for this:

- difficulties of assembling the kit;
- fear of the technology not working;
- why use the kit when other methods work?

Using handheld technology such as the TI-84 Plus with a CBL 2 gets around the first problem, while the free training available using T³ trainers can help to get around the second. The third problem, that of teacher familiarity with trusted methods is more difficult because there is rarely time to experiment and try out new approaches. However, I would encourage teachers to use data loggers, because they afford a means of collecting reliable data over long and short time periods.

Two examples that show this well use the 'CBL Physics App for TI-83 Plus / TI-84 Plus', which can be found in the free downloads section on the TI UK website, under the heading 'Free Apps for TI-83 Plus Family, TI-84 Plus Family'. The temperature and voltage probes used are supplied with the CBL 2 but you will need two temperature probes for investigating freezing water.

Hope's Experiment

200 years ago, while Thomas Charles Hope (1766-1844) was Professor of Chemistry at Edinburgh University, he published a paper in which he showed that water has its maximum density at about 4°C. This fact is well known to fish, which seek out the warmer, "heavier" water at the bottom of ponds in freezing weather.

Without this property of water there would be no life on this planet: lakes and oceans would freeze from the bottom up and would be frozen solid (see http://en.wikipedia.org/wiki/Water_(molecule) for a more detailed discussion).

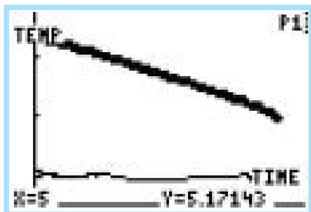
This apparatus on the right may be found in many schools, but my own observations are that few teachers know what it is for. The tall central cylinder is filled with water and a freezing mixture of ice and salt is placed in the collar around the middle. Then the temperatures at the top and bottom of the tall cylinder of water can be measured and monitored over time. As the collar chills the water in the middle, it becomes denser and falls, lowering the temperature at the bottom. Traditionally, thermometers would be read at regular intervals and graphs drawn by hand, but the data logger collects the data and draws graphs like those below as the experiment proceeds. Here, temperatures were collected at five-second intervals over fifteen minutes.

Hope's apparatus.

The thick line shows the temperature recorded at the top and the thin line at the bottom.

Temperatures recorded over the first 5 minutes.

When the temperature at the bottom reaches about 4°C it remains constant while the temperature at the top continues to fall.



The next 5 minutes

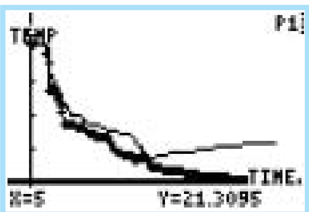
The temperature at the top falls to 0°C while at the bottom it remains at 4°C.

The final 5 minutes

If you don't have Hope's Apparatus, just add ice to a beaker of water and measure the temperature top and bottom as shown here. The CBL 2 is set up with two temperature probes supported at the top and bottom of a 250ml beaker.

The beaker is three quarters filled with water and topped up with crushed ice. Temperatures are again recorded at five-second intervals over fifteen minutes and students observe that the bottom of the beaker cools as rapidly as the top. This is not the same set-up as the original Hope experiment as the water is being chilled from the top, not from the middle. It nevertheless provides a simple method to allow students to investigate the peculiar density variation of water (which science teachers know is due to the hydrogen bond!).

Salt can be added to the ice carefully at the top (try to heap the salt on top of the ice so that it does not fall through), in order to provide extra cooling so that the bottom is forced down to the 4°C point. For the graph below, salt was added after about 5 minutes and is shown as the first point at which the thick line (top temperature) and thin line (bottom temperature) separate: the top temperature plunges more rapidly and the bottom drops a short while later until it reaches 4°C (the divisions on the temperature axis are 5 degree divisions). The graph shows that the temperature at the top will continue to fall while the bottom remains at about 4°C and even rises slightly while the top has continued to chill.



A typical graph

This could lead to a discussion of why the addition of salt lowers the temperature more rapidly – a method used historically in many countries for the production of ice-cream.

One advantage of logging data in this way is that the lesson can continue while logging takes place with the graph appearing in real time. The graph itself is great for interpretation both from the simple "what happened at this point?" and "can you explain why this is happening?". Using handheld technology means that the investigation is easy to set up in a wet environment with the kit being reasonably small and easy to manage. By contrast, with data logging using a PC, although it is possible to log remotely it is not usually possible to watch the graph evolve in real time.

Changing filament resistance

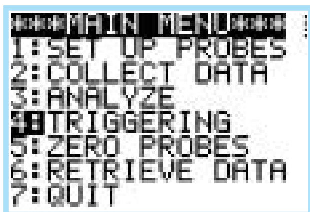
Students are expected to know that electrical resistance increases with temperature in a filament as well as have a working knowledge of Ohm's Law and how to apply this knowledge in sensing systems. It is my experience that students fail to relate the standard experiment of measuring the resistance of a bulb filament for different currents with what happens to a real bulb when switched on. This simple experiment allows the student to see exactly what happens to a bulb filament as it is switched on.

Electric current through an indicator bulb can be conveniently measured by using the CBL 2 and its voltage probe to measure the voltage across a 1W resistor in series with the bulb, as shown in the picture below. This saves buying current probes!

The power of the resistor should be chosen to cope with the maximum current: in this case quarter watt resistors are fine and cost very little. Explaining this reinforces Ohm's Law (V=IxR) for students (the numerical value of the voltage across a resistor equals the numerical value of the current through the 1 resistor).

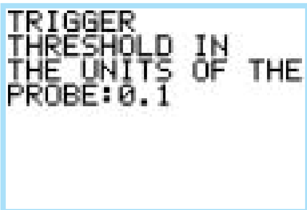
It is very easy to hook the voltage probe leads onto the resistor terminals, but make sure the polarity is correct.

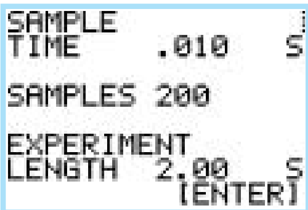
The 'CBL Physics App for TI-83 Plus / TI-84 Plus' allows you to set up data collection very easily. From the main menu choose option 4:TRIGGERING



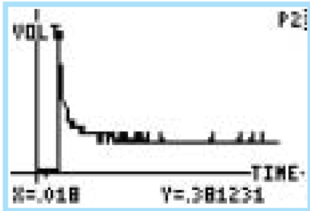
Circuit and probe leads connected across the resistor

Choose Channel 1 from the next menu and then the choices shown below to set up a trigger, say 0.1 volts (increasing). Set the pre-store to 10% to ensure that data collected is included just before the trigger threshold is reached. Set the experiment length to about 2 seconds.





It helps if the batteries are a little flat or if the voltage selected is a little less than the bulb voltage. A typical graph like that below is interesting, showing a sudden rise in current as the circuit is switched (remember that the voltage axis is in fact showing current!), followed immediately by a fall to a new lower current as the bulb filament warms up in a few tenths of a second. In describing what is happening at different points, students will develop a better understanding of what is going on as the resistance in the circuit changes. A great thing is that it is so easy to collect another data set for different bulb filaments at different voltages.



Graph showing the fall in current (NOT voltage!) through a bulb as it is switched on.

Graph showing the rise in voltage across a bulb as it is switched on.

The voltage probe can also be fixed across the bulb itself, in this case measuring the ***voltage*** across the filament and the resulting graph below, compared to the one above showing ***current*** through the bulb. It becomes obvious then that, as the current through the bulb falls, the voltage across it rises. Both of these things happen because the filament resistance is rising as its temperature increases.

The two investigations described in this article illustrate data logging over both long and very short time intervals. Both therefore show the real advantages for the use of data loggers in the classroom. It is a waste of time to watch and record temperatures over long time intervals and it simply would not be possible to record current and voltage over an interval of a second. Handheld data loggers are a little personal, giving students some ownership over what they do and of course they are easy to manage in a laboratory situation. Both of these investigations fit the new exam specifications' content known as "How Science Works" in that they reveal to students how we know what we know, rather than simply telling them what we know. The use of handheld technology within the laboratory lends itself to an investigative approach while the graphic calculator provides the obvious link for collaboration between the science and maths departments.

Ian Galloway works at the Science Learning Centre South East, based in the University of Southampton. Anyone wanting further information or help with interpreting graphical features is welcome to contact him at irg@soton.ac.uk .

Sounding out understanding!

Roger Fentem

Roger Fentem

How do you introduce Year 8 students to the terms 'frequency' and 'amplitude' in describing sound waves? Do your Key Stage 3 students relate high pitch to high frequency and high amplitude to loudness? How good are they at comparing and interpreting wave forms in terms of pitch and loudness? Are you looking for a practical activity to enable your A-level students to test their understanding of circular functions? These are a few of the issues that can be tackled with the data-logging activity described here by Roger Fentem.

You will need the generic data logging device known as a CBL 2, a Vernier microphone (guide price £39), a TI-83 Plus or TI-84 Plus graphics calculator and a selection of sound sources. The calculator needs to have the CBL Physics App for TI-83 Plus / TI-84 Plus. If it is not already in the APPS list, it can be obtained from the free downloads section on the TI UK website, under the heading 'Free Apps for TI-83 Plus Family, TI-84 Plus Family'. This App allows the teacher or student to employ a very wide range of data logging devices in an equally wide range of experimental contexts. The configuration is relatively straightforward and is helped enormously by on-screen prompts.

This article describes the stages of an investigation conducted by a year 8 student, Aala. Her teacher had attended an in-service course which had included training to accompany the KS3 Science Unit 8L "Sound and Hearing".

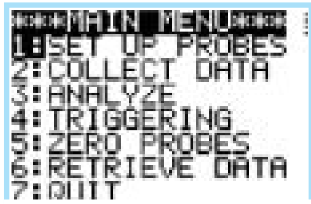
Configuring the data logger

For this experiment, the student needed to configure the CBL 2 to record the waveform of a sound, which would be detected by the Vernier microphone that was plugged into Channel 1. The TI graphics calculator would used to control the experiment, store and display the results. The procedure was very easy and is shown, step-by-step below.

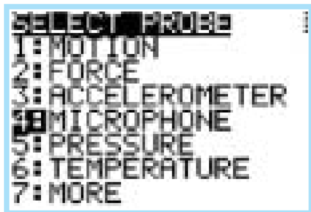
Select the Physics App by pressing the **APPS** button, scrolling down to **Physics** and pressing **ENTER**.

Press **ENTER** again to see the main menu.

Select the first option **1:SET UP PROBES** by pressing **1** or **ENTER**.

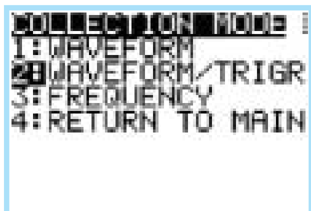


Choose the fourth option **4:MICROPHONE** by pressing **4** or scrolling down and pressing **ENTER**.

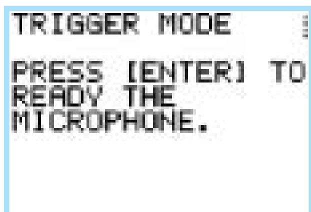


Press **1** or **ENTER** to select the first option **1:CBL**.

Choosing to collect the data in **2:WAVEFORM/TRIGR** mode is a nice feature. It means that, once the system is "readied", the CBL waits to record the data until there is a sufficient intensity (amplitude). Press **2** or scroll down and press **ENTER**.



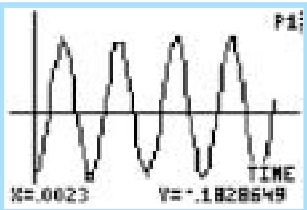
And that's it - everything is ready to go.

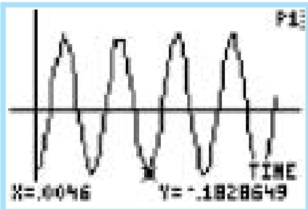


Collecting the data

Aala pressed **ENTER**, struck a tuning fork and held the vibrating end close to the microphone.

When the intensity reached the threshold level the data were recorded and displayed. (Time values are stored in list [L1] and amplitude in [L2].) The calculator is automatically in trace mode, so the cursor keys (> and <) could be used to explore the features of the output, comparing the vibrations of the fork and the oscillations of the graph.



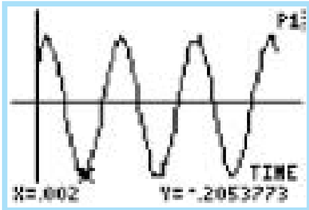


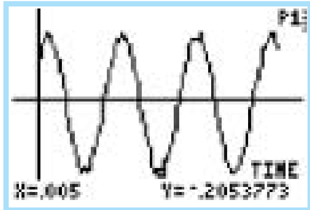
In this mode, the total collection time is fixed at 0.01 s, and Aala noted that there were just over four complete cycles in this short period of time. She conjectured that this meant there would be just over 400 cycles in one second.

Where does she go from here?

The time between peaks (or troughs) can be examined as shown in the screenshots above. Hence the period can be determined with greater precision. Here it was 0.0023s to two significant figures. (After the data collection process is complete, an examination of the data held in lists in the calculator can reveal a greater number of digits in the recording.)

With this information to hand, Aala realised the implications for the period and how this related to the frequency of the tuning fork used. The calculator can be used to provide the information that 0.0023^{-1} is 435Hz, (close to the known frequency of 440Hz for the note A).Aala listened to the note A from the tuning fork, then qualitatively compared this note with a tuning fork for the note E. Were they the same? Was one higher than the other? What differences would be expected in the waveforms for different notes? A chance to conjecture, make a prediction and then repeat the data collection with the different tuning fork.





Above are the waveforms Aala recorded. She noted the differences deciding that there were fewer cycles and hence that the periods were different. The period for the new tuning fork was apparently 0.003s. She observed that the frequency was therefore different (0.003^{-1} is 333Hz, close to 329.6Hz for the note E).

She also noted that the *amplitudes* of the two waveforms were different. This lead her to an examination of the circumstances that give rise to this – was this because of the different notes or was there some other cause?

Controlling the variables

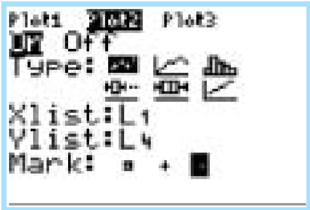
In the second part of the activity, amplitude/loudness was introduced. Aala decided to control for the pitch of the note, collecting data from a soft and a loud version of the same note. In essence the data collection aspects were essentially the same as in the frequency/pitch activity but some additional calculator skills were needed.

The **Physics** App stores the amplitude from the microphone in list [L2] in the calculator. Each occasion the collection takes place, the existing data are replaced by new data. To retain the data from one experiment to use later, it is necessary to store the data elsewhere. Neither of lists [L4] or [L5] is used by the App, so these could be used.

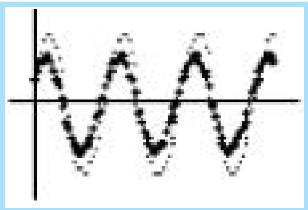
Aala collected some new data and used **7:QUIT** to leave the **Physics** App. Then she copied the data from [L2] into [L4].

She now collected data for the same note but recorded more softly by holding the fork further from the microphone. The data for the load note were now in [L4] and for the soft note in [L2].

To view the waveforms in a single graph, set up **Plot1** as a scatterplot of [L2] against [L1], and set up **Plot2** as a scatterplot of [L4] against [L1].



Using option 9 (**ZoomStat**) from the ZOOM menu ensures that both sets of data are visible on the graph.



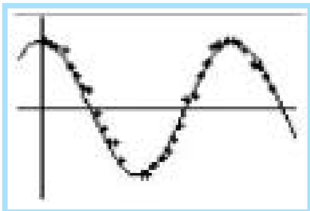
Aala was now in a position to note the differences and the similarities between the two sets of data i.e. between two notes with the same pitch but different amplitudes. The equality of the periods of the two collections of data was very clear, as was the difference in the amplitudes of the two.

Curriculum Relevance – Both Science and Maths

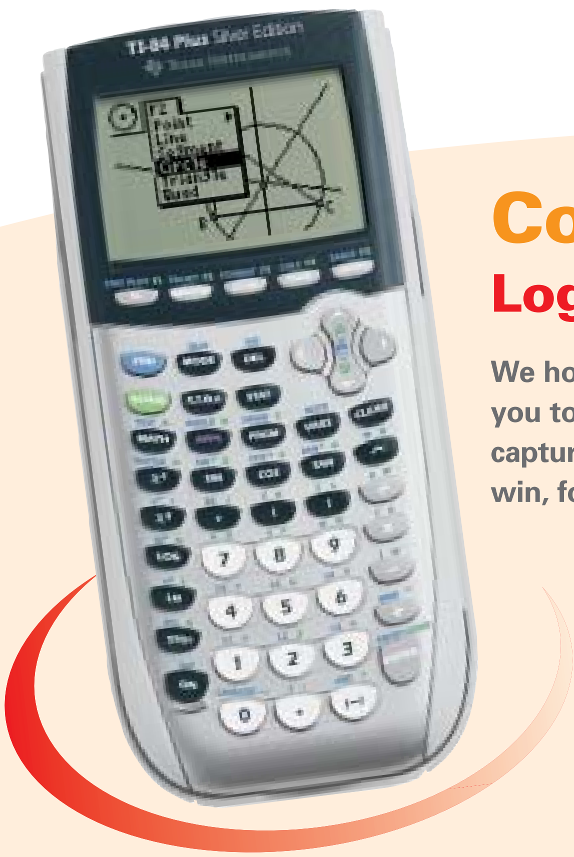
This activity clearly addresses the learning objectives of the "Sound and Hearing" KS3 Science unit on "How are different sounds made?":

- to use appropriate scientific language to describe features of a sound wave;
- that sounds with high pitch have a high frequency;
- that sounds with a high amplitude are loud;
- to relate their results to scientific knowledge and understanding.

The waveforms also lend themselves to mathematical exploration. For example it is appropriate to model the collections of data associated with the note from a tuning fork by fitting a function of the form $y = a \sin(bx + c) + d$. Such a regression calculation is easy on the calculator, using option C, **SinReg** from the STAT CALC menu. The graph below, for example, shows the result of entering **SinReg L1,L2,Y1**



Roger Fentem is head of the Secondary Mathematics Education Department at Marjon, the College of St Mark & St John, Plymouth



Competition Time

Logging the excitement

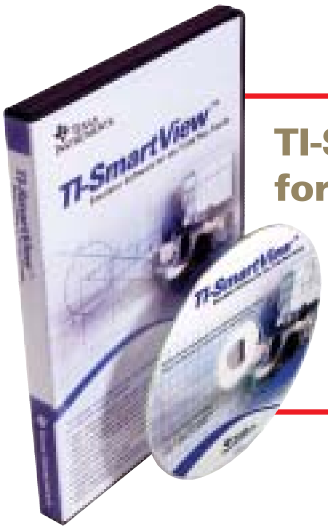
We hope that the articles in this edition of TI-Time will stimulate you to try some data logging in your classroom. If you can capture on camera the excitement that's generated you could win, for yourself or your school, a TI-84 Plus Silver Edition.

To enter this competition you must send us a picture showing the action, which we can publish in the next edition of TI-Time. Please send a paragraph describing what is going on too.

Please send your entry together with your contact details to: Barrie Galpin, 15 Top Lodge, Fineshade, Corby, Northants NN17 3BB or email to barrie.galpin@zen.co.uk.

It must arrive by 30 April 2007 and the winning entries will be published in the next edition of TI-Time. The editor's decision is final.

TI-SmartView™ – making a PC behave like a GC!



TI-SmartView™ has been shortlisted for a prestigious BETT Award.

The winners are announced every year at the BETT show and they reward innovative technological products and services that are proving to be effective in the education sector.

BETT AWARDS 2007 SHORTLISTED

Sue Pope and Andy Darbourne, who work with beginning teachers of secondary mathematics at St. Martin's College, Lancaster are enthusiastic users of this software, as they explain below.

What does TI-SmartView do?

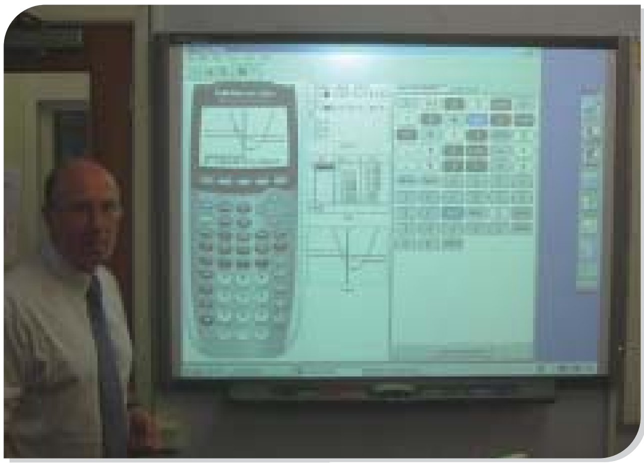
The TI-SmartView emulator is an easy-to-use, demonstration tool for the classroom teaching of maths and science concepts. Used with a TI-83 Plus or TI-84 Plus, TI-SmartView displays an interactive representation of the calculator and is fully compatible with interactive whiteboards.

What makes it so useful?

Learning mathematics is inexorably linked with understanding how mathematics can be represented in very different ways. The graphics calculator exemplifies the link between numerical, analytical and graphical representations and this is at the very heart of algebra. TI-SmartView makes these links available to the teacher for whole class, interactive demonstration and discussion, because all three modes are displayed alongside one another.

One of the major strengths of this software is that the large clear calculator makes it easier for students to follow instructions when you are introducing some new function. Students can come and 'touch the virtual calculator' or you can use a wireless keyboard or a tablet PC with great ease. The fact that all the key strokes are displayed is a real boon, especially for students who want to repeat a process or have made an error and need to retrace their steps or start from scratch! Having such a large graphing screen can also be very helpful.

At St. Martin's College we make use of graphics calculators in mathematics courses with undergraduates, primary student teachers specialising in mathematics and all secondary student teachers. TI-SmartView has enhanced our teaching by making it easier to demonstrate new procedures, for students to share solutions to problems with the rest of their group and exemplifying the links between different representations in both algebra and statistics, see below for an example of the former.



Andy Darbourne in action with SmartView

Try it for yourself!

You can request a 30-day trial CD of TI-SmartView 2.0 by calling 020 8230 3184.

Why go for Texas Instruments?

Chris Olley

Just what is the difference between Texas Instruments and Casio handheld technology? Chris Olley of Education Interactive expresses his personal view.

You've been thinking about using graphics calculators for some time and you've got that old Casio that sits in your drawer. Someone suggested that TI may be better, but you need to be convinced. What difference does it make?

Well on one level, not a lot really. A graphics calculator is a device that enables the teacher to display mathematical data in a variety of forms, quickly and powerfully. Functions, their graphs and tables of values can be generated. Equally, data can be analysed with statistics and a range of charts very quickly. Activities investigating number and algebra can be formulated. Best of all, for relatively modest outlay and with very high reliability, students can investigate mathematical ideas with a machine on their own desk, in their own hands. The first thing to look at, though, is build quality: a TI-84 Plus is built like a tank and suitable for any tough classroom!

The next issue is that we are working in the computer age. Teachers are more familiar with computer software than with calculator systems. Teachers are put off by the apparently steep learning curve of graphics calculators and worry that their students will not be able to use the machines.

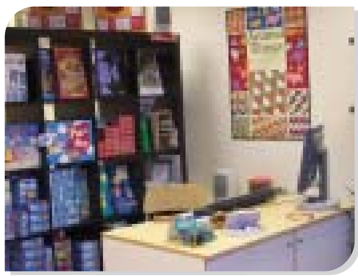
The TI operating system has remained essentially unchanged since the arrival of the TI-81 in 1990. It was initially built using the conventions of mouse-driven computer software and remains that way. If you are used to drop down menus and tabbed dialogue boxes that are the essential interface in any Mac or PC software, then the TI machines will be immediately familiar. A TI graphic calculator is not really a calculator at all – it is quite clearly a handheld computer. The core operating system does all of the number work, graphing and statistics. However, it is capable of running a range of additional applications including versions of many well-known commercial applications (which are either included or free to download). For example, if you are a user of Cabri Geometry, then seeing Cabri Junior running on a TI-84 Plus is a revelation. It looks the same, works the same and can even share files with the full version. Keyboard and display conventions are the same as computer keyboards, so 2^3 is needed for 2^3. In the computer age this consistency is essential for learners and experienced users.

On the other hand, Casio design is still rooted in calculator thinking: conventions are the same as on scientific calculators and there is no facility for applications to remain stored in the machine. The function keys are used to navigate changing menus and this is a convention from pre-windows software. This may be perfectly satisfactory in use and can even sometimes be a little quicker, but it is neither flexible nor suited to exploration.

That steep graphics-calculator learning curve is still an issue, but with TI it is at least a short curve and there is lots of help available. TI supports "Teachers Teaching with Technology" (known as T^3), an international organisation of teachers and teacher educators who meet regularly to develop teaching ideas and materials. It is this network that provides training, freely available for schools, local authorities and universities.

Finally, if you haven't seen the joyful distance-time activity using a CBR 2 as seen in the DfES video case studies, then your class hasn't lived! Excellent live data logging with easy, classroom savvy equipment is possible and with TI-InterActive It can be quickly and easily formatted into top quality output.

Ultimately, the real difference is that TI handheld technology is rooted in the education and education-research communities, with training, support and a range of products that takes account of exciting new thinking.



www.education-interactive.co.uk

Chris Olley runs Education Interactive, a group of experienced educationalists in mathematics and in equalities who work together with designers and programmers to prepare teaching and learning materials for print, for INSET and for the web. They also have a shop in south east London that sells a range of maths education products.

Professional Development from Teachers Teaching with Technology™

T³ EUROPE

At Texas Instruments we are committed to providing excellent professional development courses for maths and science teachers. The aim is to support teachers in using TI handheld technology to encourage students' exploration and visualisation of concepts and, ultimately, improve their understanding.

Training dates in 2007

Location	Date
Cambridge	3rd May
Bristol	10th May
Plymouth	17th May
Swansea	17th May
Edinburgh (Residential)	25th/26th May
Belfast	7th June
Sheffield	7th June
Aberdeen	8th June
Milton Keynes	11th June
Durham	14th June
London (Residential)	15th/16th June
Glasgow	21st June
Southampton	28th June

What's included?

- A full day's hands-on tuition in a small group.
- Basic calculator skills in the context of a range of activities from KS3 to sixth form.
- The support of an experienced tutor
- A TI-84 Plus Silver Edition teacher calculator to use and take away at the end of the day.
- Lunch and other refreshments during the day.
- Classroom materials to use in your teaching after the course.
- A special-offer order form to purchase further discounted equipment.

The price of the regional training days, including the provision of the most up-to-date calculator, is just £80 per person.

The residential events (for more advanced users) include all of the above and one night's accommodation at the training venue at a cost of just £125 per person.

How do I book?

To book places, please either complete the form on our website, call us on 01604 663077 or email us at t3@ti.com with your name, school name and address and the course that you are interested in. TI will invoice you or your school after we receive your booking.

T³ also offers free on-site professional training to meet the specific needs of groups of 8 or more teachers or PGCE students. You provide the site, T³ will provide an experienced tutor and arrange equipment to borrow. You and the tutor plan the programme. Please contact us to discuss the possibilities further.

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