# TI-Time: Science

Autumn 2002

## Dear teacher

Welcome to this first edition of TI-Time: Science. TI-Time has entered the electronic age and will be available by email subscription from now on. We've also split it into two issues for Mathematics and Science so you get even more articles that are relevant to your teaching. If you know of colleagues who would like a free subscription, simply send their email address to **mhorsburgh@ti.com** or complete the form on the TI website at **education.ti.com/uk**.

If you have suggestions for articles, or would like to contribute one yourself, please contact the TI-Time: Science editor Richard Smith at **richardfsmith@btinternet.com**. We want to make TI-Time as interesting and useful as possible and would welcome your input.

We hope you enjoy this issue – please let us know if you have any feedback.

Richard Smith
Editor, TI-Time: Science
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Melanie Horsburgh
Marketing Manager, UK and Ireland
**mhorsburgh@ti.com**

## In this issue:

- Help with datalogging and other software
- How to control a robot with your TI-83 Plus!
- A data set for your use
- News from $T^3$ Scotland and $T^3$ Ireland

## Contents

## Video: TI datalogging in science lab

Neil Anderson and Roger Fentem, two T$^3$ trainers based in England, have produced an excellent short introductory video demonstrating the use of TI datalogging technology in the science lab. Topics include fruit batteries, pH and neutralisation, 'distance matching' (with the Ranger), force and acceleration, exothermic and endothermic reactions and the use of a $CO_2$ gas sensor to record carbon dioxide levels in a lab. The material is introduced under the headings of Progression, Adding Value, Expectation and Analysis. The transfer of data from calculator to PC using TI InterActive!™ is also featured, with demonstration of the TI InterActive! graphing tool. For further details, please contact Roger at the College of St Mark and St John, Derriford Road, Plymouth, PL6 8BH, UK, email **roger_fentem@fc.marjon.ac.uk**

## ASE Annual Meeting

Two TI datalogging workshops are to take place at the ASE Annual Meeting at Birmingham University, **Friday 3 - Sunday 5 January 2003**. On the Friday at 1400, Steven England, a T$^3$ science trainer based in Devon, will present 'Cannons, Balloons and Custard Powder!,' a hands-on approach to the datalogging of modest and safe explosions! On the Saturday at 1400, Rick Sorensen (Vernier Software and Technology, Oregon, USA) and Richard Smith (T$^3$ science trainer, England) will be presenting 'Vernier Probes for TI Datalogging;' this will be a hands-on experience of a variety of Vernier probes, both 'everyday' and exotic! Rick and Richard will also be available at the TI Stand throughout the conference.

## TI BETT Technology in Practice Workshops

You are invited to the Texas Instruments BETT Technology in Practice Workshops at the Hilton London Olympia on **Saturday 11th January** 2003 from 10am to 5pm

Why not combine a visit to the UK's biggest educational technology show with one of our mathematics or science ICT workshops? Or take time out from the show to drop in for a chat about TI's training and products and some lunch.

RSVP to Melanie Horsburgh at **mhorsburgh@ti.com** by **24th December 2002**, stating which of the three Science workshops you would like to attend, and how many colleagues you will be bringing with you.

*All day: massages for weary feet; drinks and refreshments; goody bags; find out more about TI and Vernier training and technology for schools*

| Mathematics | Science | Refreshments |
|---|---|---|
| **10.30am - 12pm**<br>ICT in Secondary Mathematics Session 1<br>*Workshop leader:*<br>*Professor Adrian Oldknow* | **10.30am - 12pm**<br>Data-logging in Secondary Science Session 1<br>*Workshop leaders:*<br>*Richard Smith and Rick Sorenson* | **10am - 11.30am**<br>Coffee, Tea and Pastries |
| **12.30 - 2pm**<br>ICT in Secondary Mathematics Session 2<br>*Workshop leader:*<br>*Professor Adrian Oldknow* | **12.30 - 2pm**<br>Data-logging in Secondary Science Session 2<br>*Workshop leaders:*<br>*Richard Smith and Rick Sorenson* | **11.45am - 3pm**<br>Lunch |
| **2.30 - 4pm**<br>ICT in Secondary Mathematics Session 3<br>*Workshop leader:*<br>*Professor Adrian Oldknow* | **2.30 - 4pm**<br>Data-logging in Secondary Science Session 3<br>*Workshop leaders:*<br>*Richard Smith and Rick Sorenson* | **4 - 5pm**<br>Coffee, Tea and Pastries |

All workshops will focus on the use of handheld technology and computer software in the English curriculum.

Equipment to use in the workshop, delegates packs and training materials will be provided.

# SOFTWARE! SOFTWARE!

*Richard Smith*

Helpful hints for:

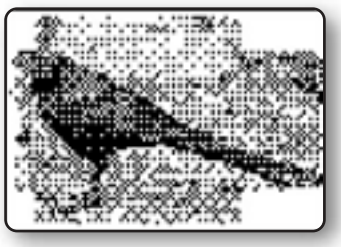
- connection to PC/MAC
- successful datalogging
- using Science Applications.

### TI Connect™

This is the new free software for connection between PC or Mac and TI-73, TI-83, TI-83 plus, TI-89, TI-92, TI-92 Plus and Voyage™ 200 calculators. The version 1.1 currently available on the TI Education site is needed for connection to the Voyage™ 200. You can download it from the site, although the Windows file is 8.2 MB! Alternatively, you can obtain a CD containing the software from the TI Customer Service Centre, **ti-cares@ti.com**.

TI Connect™ supports the use of serial and TI-GRAPH LINK™ USB cables. The 1.15 o/s (operating system) for the TI-83 Plus calculator allows full connectivity with TI Connect.

Watch out for the article on TI Connect in the next edition of TI-Time: Science. Suffice to mention here that files can be dragged and dropped between calculator and computer, list data can be viewed, edited and saved, screen shots can be saved in a number of formats, the entire RAM of a calculator can be backed up and restored in simple user-friendly operations, and with a live internet connection new versions of APPS are searched for and downloaded. It is even possible to open your favourite .jpg or .bmp picture and download it to a calculator, size and pixel number permitting!



### Calculators and CBL 2™s.

Your TI-83 Plus calculators and CBL 2s are upgradable. For information on the latest operating systems, see the article on 'Datalogging with DataMate.'

Before using your TI-83 Plus calculators for datalogging, it is useful to reset the RAM, especially if other students or teachers have been using them! Go to [2nd] [MEM] > 7:Reset > 1:All RAM > 2:Reset. Applications and archived files are not removed. For effective datalogging, you must have at least o/s 1.1 on your CBL 2. Most of the sensors available for the CBL 2 are 'auto ID' and are recognised automatically when plugged in to the datalogger. Some, including those with a DIN-BTA adapter, are not, and for these you need to go into 1:SETUP > highlight the appropriate channel > [ENTER] and then select from the menus. When an 'auto ID' sensor is plugged in a 'CHECKING SENSORS' message is displayed on the calculator. If you do not get this message when a sensor is attached or it is clear that the sensor is giving a false reading (e.g. a negative one), press [CLEAR] on the calculator to get the 'CHECKING SENSORS' message or before moving to the 'SETUP' process.

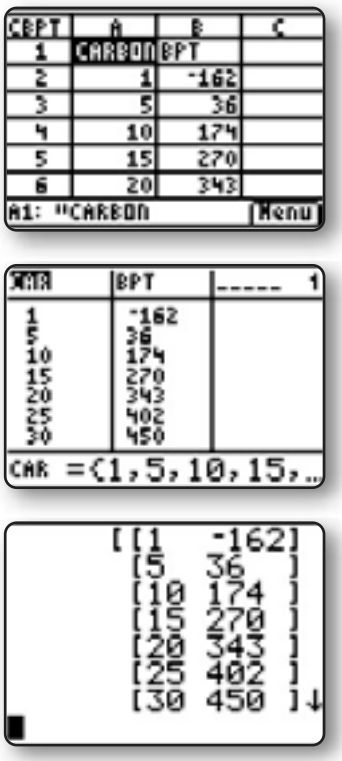
### Rangers – CBR™

Your Ranger can be used attached to a CBL 2 via the special grey cable or direct to a calculator using the very useful extra long black connector. When you plug it in to the digital channel of a CBL 2, it is 'auto-recognised' as a motion detector. For direct use with a calculator, the CBL™/CBR™ application which comes pre-loaded on an TI-83 Plus model can be used. Should you remove the application from your calculator, it can be retrieved from the TI Education site. A 'Ranger' program can be transferred from the Ranger using the [2nd] [LINK] [RECEIVE] procedure on the calculator, but this program is the same as the one found within the CBR/CBL suite, and, in any case, is deleted from the calculator when the CBL/CBR Ranger program is used! The CBL 2-DataMate set up gives much more versatility with real time graphs.

### Applications

A number of excellent Science related applications (APPS) are available for TI-83 Plus calculators. There will be a full review of these in the next edition of TI-SCIENCE.

CellSheet™ is the spreadsheet APP. You can use it as a fully functional 'stand alone' spreadsheet. You can also import data from datalogging investigations, transfer data in CellSheet, list or matrix format to other calculators and, via TI Connect, export data in list or matrix format to a text file or another calculator format such as TI-89. In addition, the new TI CellSheet Converter software provides an Microsoft® Excel 'plug in' and can also be used for converting CellSheet files from one calculator format to another (e.g. from TI-83 Plus to TI-92 Plus) or into tab delimited .txt files.

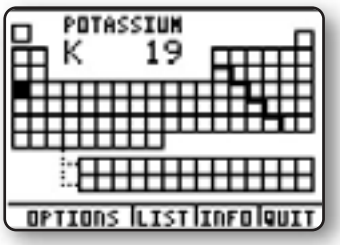


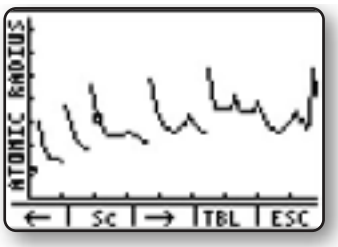

*These three screen shots show alkane/boiling point data in CellSheet™, list and matrix formats.*

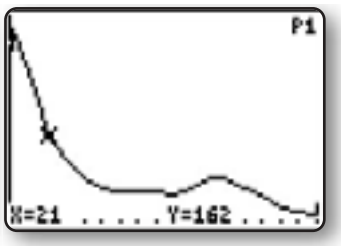
# SOFTWARE! SOFTWARE!

*continued*

The Periodic Table APP provides table and list views as well as other options such as 'graph properties' and 'export properties'. Selecting 'graph properties,' you can, for example, plot atomic radius against atomic number. You can also export this data to lists for more detailed analysis.




*The second of these screen shots shows the atomic radius graph produced within the APP. The third is a plot produced using calculator tools after the atomic radius data has been exported to lists, with element 21 (Sc) and at.rad. 162 highlighted.*

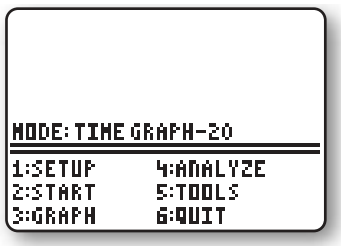
If the CellSheet™ and Periodic Table APPS were not pre-loaded on your TI-83 Plus model, they can be purchased at the TI Online Store via the TI Education site. You can also obtain a free 'demo' version of Periodic Table from the site. The Fundamental Topics in Science APP gives an introduction to, outlines the ideas behind ('concepts') and provides a number of activities for topics such as 'Scientific Method,' 'Precision and Accuracy' and 'Scientific Notation.' With the Science Tools APP you are provided with a number of useful tools such as a significant figure calculator, a vector calculator and a unit converter. You can purchase the Fundamental Topics APP and, if not pre-loaded, download the Science Tools APP for free via the TI Education site.

# Datalogging with DataMate

The new fast assembly language (ASM) DataMate has just been released by TI **in conjunction with the TI-83 Plus operating system 1.15 which** *must* **be used with it.** Both the CBL 2 update 106 and calculator o/s 1.15 can be downloaded from the TI site at: **http://education.ti.com/us/product/tech/datacollection/apps/apps.html.**

A few hints that may prove helpful:

1. Save the files on your hard drive.
2. Use the Backup feature on TI Connect to back up all of your calculator files to one computer file. Or make certain that all of your valuable calculator programs, pics and variables are archived. First procedure recommended.
3. Connect calculator to computer with either a serial or USB cable. Display the OS115 file in the appropriate window and either drag it onto the desktop TI Connect icon or right click > Send To > Connected TI device. When the o/s update has finished, RAM is cleared. APPS and archived files are not removed. You can now use the Restore feature on TI Connect
4. Make certain that the CBL 2 has good batteries or use a mains adapter; the ViewScreen one fits. Connect CBL 2 to computer with either a serial or USB cable. Display the 106 updater and double click. The transfer begins automatically and **only takes from 2-3 minutes**.
5. Connect calculator to CBL 2 and put calculator into receive mode :-[2nd] > [LINK] > [RECEIVE] > [ENTER]). Then press TRANSFER button on the CBL 2. When done, open DataMate on the calculator and the brief opening shot will read DataMate ver 1.14 and ROM 1.12
6. As you can see, the time interval between screens is now very short!!!



# TI calculators in control

*Adrian Oldknow: a_oldknow@compuserve.com*

All the current TI graphical calculators have an I/O port through which they can communicate with each other, with PCs & Macs, and with other compatible equipment such as the Calculator Based Laboratory (CBL) and Calculator Based Ranger (CBR). Their programming language includes the commands Send and Get to send a list to and receive a value from the I/O port. The microprocessor in the CBL and CBR can be programmed via lists sent by the Send command, and can return data to a variable by the Get command. Thus, for example, the RANGER program built in to the CBR is a program written in the BASIC-style TI programming language using the Send and Get commands. The original CBL had six built-in ports for use with a variety of sensors and devices; three of these were analogue inputs for use with sensors such as the temperature, voltage and light intensity provided. A sonic port was used for connection with a motion detector, such as the CBR. The other pair were a digital input and a digital output, each providing four data lines.

This gave the idea for a first attempt at a robotics project – the CBME (or Calculator Based Mars Explorer) – a simulation of the Sojourner remote controlled vehicle used to explore the surface of Mars. The chassis was built from (mainly pre-war!) Meccano parts, and powered by a 6-volt Meccano motor driven through a gear-train. The problem was to work out how to switch the motor on and off, and to move between forward and reverse. This required a relay to be programmable via a Haven digital control box designed for primary school D&T work by a colleague, Dr. David Argles. Thus only two digital output lines were needed: one for on/off and one for forward/back. The other two digital lines were used to sound a buzzer and flash a lamp bulb. So only the Digital Output of the CBL was needed to control the output devices: the motion of the vehicle through the relay and the optical/audio signals through the buzzer and bulb. The inputs were a light sensor attached to Channel 1 and a CBR attached to the sonic port. The calculator program just had to work with the CBL to do the following:

- read the light sensor until the value exceeded a trigger value (simulating the sun rising over Mars);
- then start the motor running forward and read the data from the CBR;
- until the distance from the nearest object is less than 1m;
- then stop the motor, sound the buzzer and flash the light for 10 seconds;
- then start the motor running backwards for 5 seconds;
- then stop.

*This picture show the original CBME – still in running order using a TI-83:*

The trouble now was that the CBL had been replaced by the CBL2 with no separate Sonic, Dig In and Dig Out ports and so unless you had an old CBL you would have to use Vernier's (**www.vernier.com**) more sophisticated version of the CBL2, called Labpro, which has the appropriate set of ports.

While the CBME was great fun, the total cost of the kit involved (TI-83, CBL, CBR, digital control box and Meccano parts) was over £300 – and so another, cheaper, approach would be needed to make calculator based robotics a practical reality for the classroom – preferably one not based around the CBL.

The next development was a tip-off about a firm called Norland Research in Las Vegas (**www.smallrobot.com**) who had developed their own calculator based robot for use with a TI-83 Plus. For just $85.95 (plus $30.00 postage and packing) you could buy a complete kit to assemble which produced both digital inputs and outputs for feedback and control. The two driving wheels were controlled independently by servos which were programmed from the calculator. The front bumper was attached to two pressure pads so that a program could sense whether one or both pads detected a collision. The digital I/O was handled by a PIC (Programmable Integrated Circuit) chip mounted on a small card under the robot's chassis. In order to communicate with the chip Norlands had developed some assembler code called SRBTEST (in ZASM) which had to be called via the Asm command of the TI-83 Plus. Thus all input and output via the PIC chip was handled via calls to this assembler routine.

*The Mark 1 Norland calculator based robot*

The most recent big leap forward is the current version of the Norland Research Calculator Robot, at $119.90 including p&p (£85.81 in April 2002), but this time it comes ready assembled. Robot Mark 2 works exactly on the same principles as robot Mark 1, except that now there is no need for the assembler routine to handle the I/O with the PIC chip. Its software now directly decodes the signals received via the Send command, and returns data in a form recognised by the Get command – thus it will work with any TI graphical calculator which has an I/O port and the Send and Get commands. This means that realistic robotics exhibiting feedback and control can be achieved for a price of around £140 and programmed using a simple high-level language. Communication with the PIC chip takes the form:
Send({xyz,time}):Get(R)
Where xyz is a 3 digit number: x takes the value 1, 2 or 3 and y,z take the value 0, 1 or 2 given by the following table.

# TI calculators in control

*continued*

If x = 2 there is no value for “time”, otherwise the value of time is the duration in milliseconds

| x = type of motion | y = left motor | z = right motor |
|---|---|---|
| 1 = timed movement | 0 = forward | 0 = forward |
| 2 = move until switch hit | 1 = no motion | 1 = no motion |
| 3 = either time or switch | 2 = backward | 2 = backward |

Here is a complete program in TI program code to control a Mark 2 robot:

```
:For(C,1,5)                 For five times
::Send({200}):Get(R)        Move forward until switch hit
::Send({122,100}):Get(R)    Reverse for 0.1 s
::Send({120,30}):Get(R)     Spin left for 0.03 s
:End
```

*The Mark 2 Norland calculator based robot.*

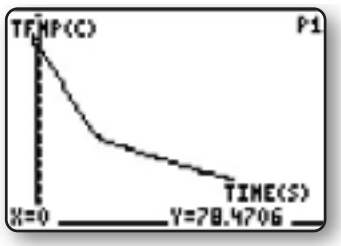
Adrian Oldknow has retired from teaching at University College Chichester and holds a Visiting Fellowship at the University of London, Institute of Education. A member of the Tcubed steering committee, he is co-author, with Ron Taylor, of Teaching Mathematics with ICT (Continuum 2000, ISBN 0-8264-4806-2) and Data-capture and Modelling in Mathematics and Science (BECTa, 1999 – downloadable in pdf format from:
**vtc.ngfl.gov.uk/uploads/application/datacapture-16796.pdf**

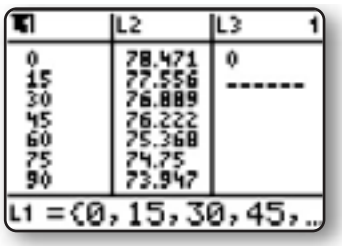
# Hot Wax!

*Richard Smith*

This simple activity, to show the temperature change in a solidifying liquid wax, has been designed as an introduction to the DataMate datalogging application. A TI-83 Plus calculator, a CBL 2 and a temperature sensor are required. Candle wax or stearic acid is melted in a bath of boiling water and kept in the bath until its temperature is just below 80°C.

1. Insert a temperature sensor into Ch 1 of the CBL 2.
2. Select APPS > DataMate > ENTER.
3. A screen will appear with CH1:TEMP(C) and a temperature reading.
4. Select 1:SETUP.
5. Move arrow **upwards** to MODE:TIME GRAPH and press enter.
6. Select 2:TIME GRAPH, then 2:CHANGE TIME SETTINGS.
7. Enter 15 (seconds) for time interval >ENTER and 120 for sample number >ENTER, to get EXPERIMENT LENGTH: 1800.
8. Now select 3:ADVANCED, and 2: CHANGE GRAPH SETTINGS.
9. Select 1:CH1-TEMP(C).
10. Enter Ymin= 30 (lowest temperature on the Y axis.) > ENTER, Ymax= 80 (highest temperature on the Y axis), Yscl= 10 (the scale on the Y axis).
11. Then 1:OK > 1:OK > 1:OK.
12. Place the temperature sensor into the tube containing the wax and press 2:START.
13. The CBL 2 ‘beeps,’ a real time graph appears and the temperature reading can be seen top right on the screen.
14. At the end of the sampling period there is another ‘beep’ and a properly scaled graph appears. The values on the plot can be explored using the left and right facing arrow keys. *If a sufficient number of samples have been collected in an investigation but the total sample time has not elapsed, press [STO>] on the calculator; sampling stops and the graph appears.*
15. Then press ENTER and select 6:QUIT.
16. An information screen then appears informing you, amongst other things (!), that TIME is in L1 (List 1 on the calculator), and CH1 in L2 (temperature readings). Now press ENTER to quit completely.
17. The lists can be viewed by going to [STAT] > 1:Edit..
18. If required, the lists in L1 and L2 can now be transferred to a PC/Mac for manipulation and analysis in a spreadsheet.
19. For heating and cooling experiments, up to three temperature sensors can be used (CH1, CH2, CH3) with the same CBL 2.



# $T^3$ Ireland summer school for secondary science and mathematics teachers

*Anna Walshe*

**Dublin City University, 25th-27th July 2002.**

In the last decade considerable development has taken place in science education, with a greater emphasis on the skills of the scientist and on scientific enquiry.

This summer, $T^3$ Ireland in association with Dublin City University ran a summer school for teachers of mathematics and science. This three day residential course was designed to help teachers enhance their students understanding and motivation for learning through practical science and mathematics.

The summer school provided teachers with ideas and classroom material to facilitate all their practical science and mathematics classes. It also gave teachers the opportunity to enhance their use of technology in a friendly and informal setting. The programme consisted of workshops with a strong practical participative element for all stages of secondary education. Workshops included electronics, instrumentation in chemistry, DNA fingerprinting and extraction, engineering, human physiology, TI handheld technology for datalogging, ecology, sports science and investigative mathematics.

Keynote speakers were Professor Martin Henry, Dr. Odilla Findlayson (DCU) and Richard Taylor, Hockaday School Dallas Texas. Guest speakers included Richard Smith ($T^3$ England) Dominic Delaney (Biorad Industries) and Jim O'Neill ($T^3$ Scotland).

One of the most important features of a gathering such as this, is the ability of teachers to share ideas. The three day long summer school gave teachers a chance to get to know each other and socialise. A highlight of the event was a conference dinner on Friday night, kindly sponsored by Shaw Scientific Ltd.. It is hoped to run the same event next year in early July; accommodation will be on the DCU campus.

Anna Walshe is the $T^3$ Coordinator for Ireland. The $T^3$ Ireland web site can be visited at
**http://www.t3ireland.ie/t3ireland/main/Home.htm**

# Data Set 1. carbon dioxide production by garden peas

*Richard Smith*

This data set was produced using a Vernier carbon dioxide gas sensor attached to a CBL 2™ datalogger. Peas were germinated by soaking in water overnight and then leaving on a bed of damp tissue paper in a tray covered with perforated cling film for 48 hours. Half of the peas were then boiled and cooled.
Time is in seconds and the carbon dioxide level is recorded in parts per million (PPM).
Using the Column Select Tool in Acrobat Reader 5, you can, column by column, copy and paste the data into a spreadsheet such as Microsoft® Excel or TI-InterActive!™. Also, using the free CellSheet™ Converter software, you can easily transfer the data from Excel to the CellSheet APP on a TI-83 Plus or other calculator.

If you have any problems, email **richardfsmith@btinternet.com** for the Excel and/or CellSheet files!

| | | |
|---|---|---|
| 10 | 860.22 | 860.04 |
| 20 | 1104.59 | 840.49 |
| 30 | 1388.07 | 889.36 |
| 40 | 1583.58 | 918.69 |
| 50 | 1739.98 | 938.24 |
| 60 | 1896.38 | 957.79 |
| 70 | 2052.79 | 948.01 |
| 80 | 2170.09 | 977.34 |
| 90 | 2316.72 | 957.79 |
| 100 | 2424.24 | 987.11 |
| 110 | 2531.77 | 967.56 |
| 120 | 2629.52 | 977.34 |
| 130 | 2737.05 | 996.89 |
| 140 | 2854.35 | 977.34 |
| 150 | 2942.33 | 987.11 |
| 160 | 3030.30 | 987.11 |
| 170 | 3108.50 | 1006.67 |
| 180 | 3206.26 | 996.89 |
| 190 | 3294.23 | 1006.67 |
| 200 | 3401.76 | 1006.67 |
| 210 | 3509.29 | 1006.67 |
| 220 | 3567.94 | 1026.22 |
| 230 | 3655.91 | 1006.67 |
| 240 | 3695.01 | 1016.44 |
| 250 | 3792.77 | 1016.44 |
| 260 | 3870.97 | 1026.22 |
| 270 | 3958.94 | 1035.99 |
| 280 | 4066.47 | 1026.22 |
| 290 | 4154.45 | 1045.77 |
| 300 | 4232.65 | 1026.22 |

# Science education and datalogging in Scotland

*Jim O'Neill*

Mathematics teaching in Scotland has enjoyed something of a renaissance in the eyes of students and teachers since the introduction of the graphing calculator. It has allowed a more investigative approach to teaching and learning in certain areas of the curriculum – a scary development for some, long overdue for others.

Science education, on the other hand, has moved from a more practical and hands-on approach many years ago, to more traditional classroom methods of teacher exposition with some demonstration. There are instances of the use of computer simulation but this is not easily managed in many school systems. There has been a shift away from an investigative approach by many teachers – particularly in Chemistry, where safety requirements have placed a huge burden on many traditional approaches to experimentation.

This has been recognised by the drop in student numbers experienced in many Physics and Chemistry departments, as well as the gender differences evident in both disciplines. Scientists have been aware of this situation for some time and in recognition of the reduced costs involved and the practical approach it encourages, it is heartening to see the development of investigative approaches using hand-held datalogging equipment. Science is re-gaining an investigative bias for many students, and teachers. In schools who are using this approach, initial reports suggest a slight resurgence in the numbers adopting the three disciplines, as well as an even spread.

$T^3$ Scotland has welcomed the introduction of this technology into the hands of students. Our position has always been to support the development of technology as it enhances teaching and learning. In mathematics, we have trained many of Scotland's mathematics teachers. Our materials have been printed and are available to every teacher to use in the classroom. Our aim, now, is to support a similar development in Science.

To this end we are assisting a number of authorities to explore the use and benefits of datalogging in the classroom. We aim to provide classroom practitioners skilled in the use of this technology who will then conduct training sessions at both school and authority level. It is hoped that the outcome will be the same– to encourage students to design and conduct experiments as well as analyse their results.
This is only possible through the ease of use of the technology. Teachers and support staff are hard pressed as it is. The introduction of this technology will only be practical if it proves to be robust in use, simple to set-up and reliable over a period of time. So far the results of its use are very positive. It remains reliable and students find it easy to use. Staff are getting there also.

Staff training and development is fundamental to the successful introduction of all teaching and learning strategies and this one is no different. The recent syllabus changes saw the brief introduction of this technology at a national level. This is now being strengthened locally.

We still have a long way to go. Funding remains an issue for all disciplines as datalogging does not satisfy the whole curriculum requirement for experimentation. It is hoped that funding will be found nationally to increase the pace of this development in science classrooms.

If any reader would like to find out more about the courses and training available through $T^3$ Scotland please do not hesitate to contact us at info@t3scotland.co.uk or look on our website at http://www.t3scotland.co.uk. We are happy to discuss staff training requirements as well as offering support for in-service training.

Jim O'Neill is the Coordinator for $T^3$ Scotland

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Website: www.t3scotland.co.uk

# WOLOP

The Texas Instruments free Loan Programme helps you find out more about how our educational technology can enhance your students' learning. The Loan Programme is the ideal way for you to get TI products for teacher workshops, in-service training, or to borrow individual items so that you and other teachers in your department can evaluate them.

**What's available?**

The following products are available through the Loan Programme:

- TI-83 Plus
- TI-89
- Voyage™ 200
- CBL 2™
- CBR™
- Vernier probes for the CBL 2
- TI-Presenter™

ViewScreens and teacher calculators are optional; so don't forget to request one if you need it. And if you want posters, transparencies and literature to distribute to workshop participants, just ask.

Borrowing equipment is free and it's easy.
Reservations should be made 4-6 weeks in advance to ensure availability. Please provide the following information in your request:

- Delivery date, address and telephone number
- Quantity and type of equipment you require
- How long you would like the loan for (usually up to three weeks)

The units are packed and sent straight to you. After your workshop, you simply re-pack the cases, affix the address label provided and call for pick-up. Complete instructions are included for each loan.

**To book a loan, or for more information, simply contact:**

**Texas Instruments**
**Customer Service Centre**
Tel: 020 8230 3184
Fax: 020 8230 3132
E-mail: ti-loan@ti.com

Or book a loan on-line at **education.ti.com/uk**

**education.ti.com/uk** **ti-cares@ti.com**

## Where to buy TI Technology

You can purchase student units, teacher units, accessories, software and class sets from the following companies:

**Comcal (Scotland) Limited**
Telephone: 0141 332 5147
Email: sales@comcal.net
Website: www.comcal.net

**Jaytex Limited**
Telephone: 0161 831 7585
Email: jaytex@freeuk.com

**Oxford Educational Supplies Limited**
Telephone: 01869 344 500
Email: sales@oxford-educational.co.uk
Website: www.oxford-educational.co.uk

**Science Studio**
Telephone: 01 993 883 598
Fax: 01 993 883 317
EMail: calculators@sciencestudio.co.uk
Website: www.sciencestudio.co.uk

**Shaw Scientific (UK) Ltd**
Tel: 0870 241 6938
Email: info@shaweducation.co.uk
Website: www.shaweducation.co.uk

**Shaw Scientific Limited (Ireland)**
Telephone: 00 353 1450 4077
Fax: 00 353 1450 4328
Email: info@shawscientific.com
Website: www.shawscientific.com

**Waterstons the Stationers**
Telephone: 0131 333 6222
Email: sales@waterstonsstationery.co.uk
Website:
www.waterstonsstationery.co.uk

TEXAS INSTRUMENTS



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