connectingminds™

The resource magazine for users of TI Technology
Issue 2 2005

Index

Create an engaging, collaborative learning environment for your students….

Real-time assessment of student learning and understanding…

TI-Navigator™ – A Classroom Learning Network System

A classroom communication system that increases the teacher's ability to engage students by providing immediate feedback, opportunities for student collaboration and the ability to customise learning while utilising existing TI graphing technology. TI-Navigator™ consists of:

- **Activity Centre:** students to work together and experiment with mathematical modelling, explore families of functions, or create shared data sets
- **Class Analysis:** immediate feedback to students allows them to gauge their progress and make adjustments accordingly
- **Screen Shot Capture:** view calculator screens from the entire class, immediately see who's on task, who understands and who needs help
- **Quick Polling:** receive spontaneous feedback to gauge student understanding
- **LearningCheck™:** create assignments, tests, quizzes, send them directly to student calculators and assess electronically
- **File Transfer:** send data, Apps, window settings, etc. to the entire class or individual students

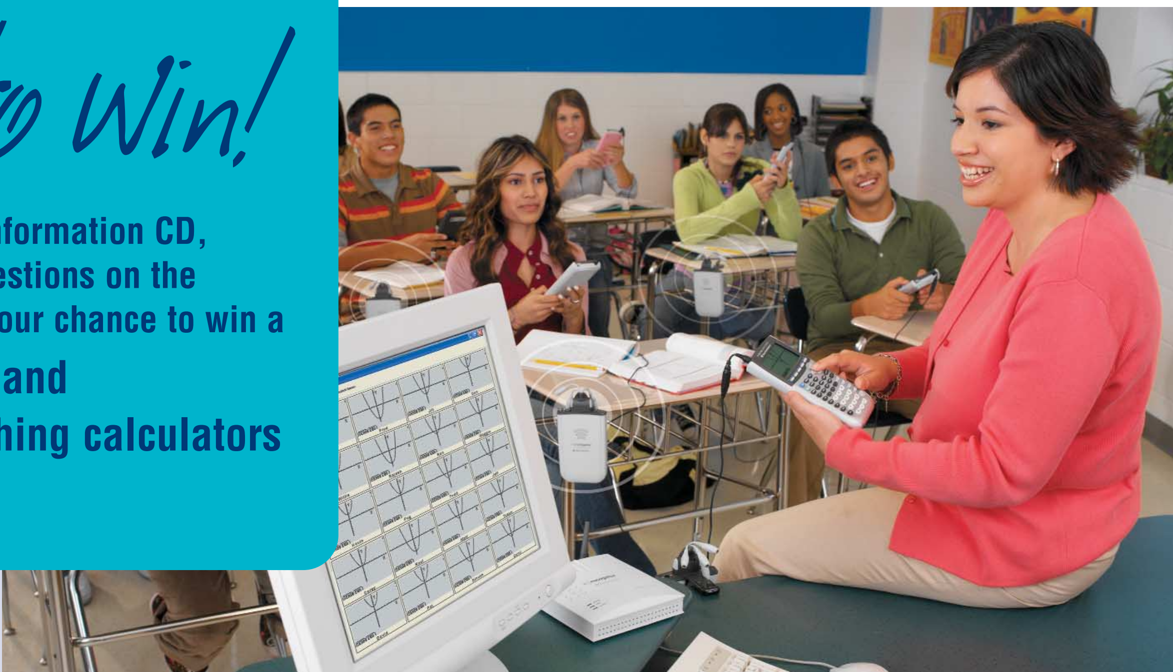
To evaluate a TI-Navigator system telephone **1300 138 140** or e-mail **teacher-support@list.ti.com**

Enter to Win!

Watch the TI-Navigator information CD, answer the 10 simple questions on the enclosed entry form for your chance to win a

TI-Navigator system and 32 x TI-84 Plus graphing calculators

(Retail value $12,000)



editor's comments by Peter Fox

After a recent review of the mathematics curriculum at my school, I came to the conclusion it needed more problem solving activities. Most mathematics teachers would be familiar with the Tower of Hanoi problem and games of strategy such as chinese checkers. I figured it would be advantageous for students to make the games in woodwork.

I started my investigations by talking to one of the woodwork teachers. I enquired about 'hand operated drills', the response was a rather puzzled look and "why would you want to use them?" It seems that the woodwork department have gone all modern and use electric drills, drill presses and even electric sanders. The 'by-hand' skills that I was taught are not valued as much.

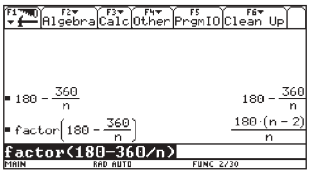
A carpenter friend of mine has three electric saws and only one hand saw in his trailer. He has a variety of nail guns and one hammer. There are electric screw drivers, planners, sanders, a laser level and huge compressor… all manner of technology, all in his trailer. The tools of trade for the carpenter have changed. The tools of trade for some artists have also changed. Next time you walk around your school, have a look in on some art classes. The 'paint' being used is just as likely to be a software package as it is a pigmented paste.

So, how does all this relate to the mathematics department? How many of us still require students to plot points and sketch graphs by hand? How many industries still have staff plotting points on a graph, by hand? Do students need to plot points by hand in order to understand the meaning of a graph; or do we need students to do it by hand so we can *measure* their understanding? After all, if a student uses a graphical calculator, how would we know if they can plot points?

This issue of **connecting**minds™ contains a number of activities that will make you think about what you teach, and maybe more importantly, how you teach it.

The robotics activity has been modified after reflecting on student conversations. When students were getting their robot to 'draw a square' they talked about getting the robot to turn 90° because 'a square has four 90° angles in it.' While the statement about the four 90° angles in a square is correct, the reasoning was most likely incorrect. The inclusion of an equilateral triangle in the task challenged the student's logic. It is the supplementary angle that is important; the polygon's exterior angles. In order to get the robot facing back in the original direction it needs to turn a total of 360°, regardless of the number of sides on the polygon.

If the students were asked to get the robot to trace out a pentagon then each turn would be equal to: 360 ÷ 5 = 72°. The interior angles in a regular pentagon would therefore be 118°. If students generalise this information for a polygon with n sides, then the interior angle is equal to: 180 – 360 ÷ n. This can be simplified, using CAS if necessary, to produce: $\frac{180(n-2)}{n}$ as the size of the interior angle on a regular polygon with n sides.

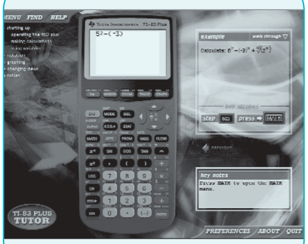


Carol Moule's activity uses probability to estimate the area bounded by the graph: $f(x) = \frac{4}{1+x^2}$, the x and y axis and the line $x = 1$, ie: Area = $\int_0^1 \frac{4}{1+x^2}\,dx$.

Increasing the number of simulations, students discover the area is approximately equal to π. Challenge students to investigate a suitable substitution for x in order to solve the problem by hand. The π result leads students to the idea of using a trigonometric substitution (ie: Let $x = \tan(u)$). It is the way the material is being taught, not just the material itself.

While I am not sure what mathematics will remain relevant to 'generation.com', I do know they will still be required to think and solve problems.

t³ asia pacific



T³ Asia-Pacific website: www.connecting-t3.com

This website just keeps growing!

Please come and take a look if you would like some great activities that can be used directly with your students, and please consider adding your favourites to share with others.

If you are a less experienced technology user then take a browse through the 'Getting Started' section, where you will find keystroke instructions for many activities and mathematical functions.

Free support for teachers using TI-83 Plus/TI-84 Plus and TI-89 calculators

Would you like a tutorial on the TI-83 Plus/TI-84 Plus or the TI-89 which can be completed in your own time and referred back to when ever you need?

Well, the 'Watch Me Ware' tutorial for the TI-83 Plus/TI-84 Plus or the TI-89 is free when you become a VIP member, which is also free. For an application form please email **teacher-support@list.ti.com**

The CAS CD-ROM covering activities for the TI-89, Voyage™ 200, Derive™ and TI-InterActive!™ is now complete and has been sent to all Victorian secondary schools, other schools which we know use our CAS technologies and individuals who have requested a copy. If you would like a copy please email **teacher-support@list.ti.com**

You can also find all the activities on the CAS CD on the T³ Asia Pacific website.

We anticipate the completion of the TI-83 Plus/TI-84 Plus CD-ROM to be early 2006.

Working with local teachers and subject associations to offer professional development

We are now into the fourth round of bi-annual Seeding Grants, with numerous successful grant projects underway across Australia/New Zealand. Seeding Grants provide the opportunity for a number of schools to access locally based professional development. Applications are available from the T³ website or can be obtained by contacting Antje Leigh-Lancaster on **pd-australia@list.ti.com**

T³ Asia Pacific works closely with Mathematics and Science Associations. These Associations are given the opportunity to offer beginner to advanced workshops to teachers in their area with T³ Asia Pacific funding presenter fees. Please let your subject association know if you are interested in some professional development based on the effective use and integration of Texas Instruments technology in the mathematics and/or science curriculum.

If you would like to discuss any of the above initiatives or some other items please contact me, Antje Leigh Lancaster, on phone **03 8540 5211** or email **pd-australia@list.ti.com**

Using Navigator: Allowing Discussion by Connecting into Students' Work

By Ian Edwards, Luther College

Earth calling, Scotty. Come in Scotty.
Can you hear me, Scotty?
Acknowledge, over.

As a teacher, have you ever felt like you were stationed on a far away planet (the front of the class) talking into the heavens, hoping for a response from the astronauts (students) in outer space (at the back of the class)? You desire feedback on what they are learning but are getting little response. In teaching, a vital issue is, 'How can you enter into their learning?' You want answers about what they have understood in the last few minutes. You wonder how you can get Marian to volunteer her answers. Your desire is for the class to enter into a cooperative learning dialogue where all students can safely contribute information and answers. The information that students contribute about their understandings is vital. It informs teaching practice.

The concept of a wireless technology connected classroom and the possible advantages this technology may give in monitoring the understanding of students, came to my attention in 2001. At the time, I was searching for articles to complete a university assignment on assessment. One journal article detailed action research on formative assessment using wireless connectivity in college classes. The overwhelming impression left by this article was that wireless connected classrooms allowed collaborative dialogue to be established in the classroom. Students provided information on their understandings in 'real-time' to inform the events of the instructional cycle. In 2003, I began to hear about a new product – the TI-Navigator™ that allowed this connected classroom to happen in schools using calculators. Because of Luther College's involvement in a research project (RiteMaths) with Texas Instruments and the University of Melbourne, I gained access to a Navigator system in 2004. The initial product was wonderful. The strength of version 1 software was in summative assessment. It gave great methods of gaining summative assessment information via CLASS ANALYSIS, but it lacked the tools to enter into a dialogue with students on their learning journey. This all changed in 2005 with the release of version 2 software for Navigator. Issues such as setting up class lists and log in procedures were simplified. New features ACTIVITY CENTER, QUICK POLL and SCREEN CAPTURE were added. In QUICK POLL, all students gained a voice to give instant feedback. Common understandings could be stated by all in the group. SCREEN CAPTURE allowed a new dimension in monitoring of students' work by viewing all calculator screens. ACTIVITY CENTER was unbelievable in its potential to generate collaborative discussion as students worked collaboratively by contributing information on points, equations or lists.

There is a catch to Navigator, and it is this. With the use of new technology comes change. Old methods of working, questioning and setting learning pathways are challenged. Here is an example of a change that happened in my class. In teaching order of operations in Year 7, students resist recording the sequence of the closures. You want students to demonstrate their knowledge of the priority for closure by recording each closure. However, as soon as you demand they show all the stages the moaning begins. Comments include, 'It takes too long to write out all the steps' and 'I know what to do, as I did it in my head'.

```
18+36/6*2
                30
18+36/12
                21
18+6*2
                30
```

Screen 1

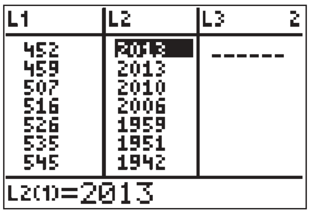
```
S+E/V*N
                42
12+60/10*5
                42
30+24/12*6
                42
```

Screen 2

For some students in year 7, simplifying 18 + 36 ÷ 6 x 2 , is difficult. Students use ingrained, incorrect operational closure sequences and changing a 'learned dysfunction' is difficult. How can you monitor what all students are doing and share this knowledge with the class? SCREEN CAPTURE provided this teaching opportunity. In addition, the technology changed the questions posed. Firstly (screen 1), students enter the expression revealing the answer (30). Now the problem became not to find the answer but to close one operator (+, ÷, x) and retain the result of 30. Next, close a second operation and retain the answer. Instant feedback to student (via calculator) and to teacher (via SCREEN CAPTURE) is available. Using Navigator, all calculators can be sent values for variables S, V, E, N. Students enter the expression S + E/V*N (screen 2). The investigation starts. What are some values for the unknown S, V, E and N so that the answer is 42? The task changes from a closed to an open investigation. Order of operation is vital in the search. Using ACTIVITY CENTER students shared their discoveries. The task opens up discussions about factors, multiples and the relationship between S and V variable values. SCREEN CAPTURE monitored the work, providing snapshots of work for all of the students. These snapshots provided glimpses into their learning journey. I have a long way to go in understanding how to utilise NAVIGATOR as an effective learning tool, but the journey will be interesting and challenging to my pedagogy.

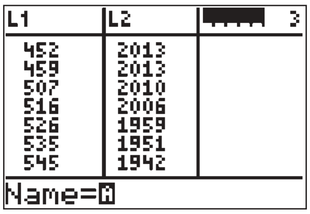
Exploring Sunrise and Sunset Data

By Neville Windsor, Hellyer College, Burnie, Tasmania, Australia



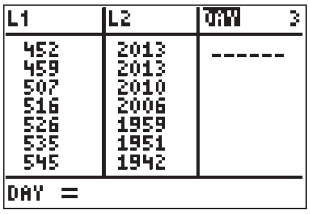
Data included in this activity was taken from http://www.ga.gov.au/bin/astro/sunrisenset – the Geoscience Australia website. The site allows the user to calculate times of sunrise and sunset (among other things) for any location and any period of time. The user must enter the latitude, longitude and time zone for the chosen location.

The purpose of this task is to determine an equation for the sunrise time throughout a 12 month period, for a specific location. We'll make the task somewhat easier by using sunrise and sunset times for every *seventh* day. The appropriate values are shaded in appendix 1.



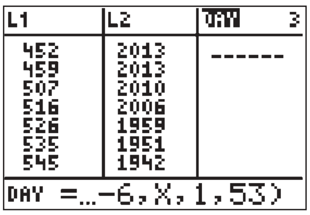
Turn the calculator on, press [STAT] and [1] to enter the list editor. Enter all of the shaded *sunrise* times into list 1 (L1), pressing [ENTER] after each one. When these have all been entered, press [►] and enter all of the shaded *sunset* times into list 2 (L2). The top sections of your lists should appear as shown.

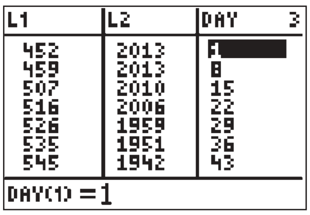
Before we can produce any graphs of the data we need another list showing the number of the day in the year. One way to do this would be to enter the numbers 1, 8, 15, 22, etc. into a list, this is tedious, instead we'll use a quicker and easier method.

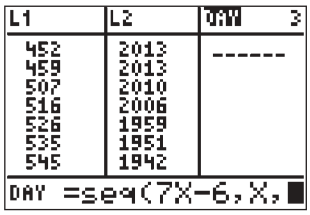


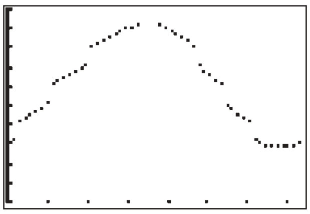
To begin, we will give the new list a *name*. Press [►] to move into list 3 and then press [▲] so L3 is highlighted. Press [2nd] [INS] to insert the name of the new list. L3 seems to disappear (it actually moves to the right and makes room for a new list, yet to be named). At the bottom of the screen you will notice "Name=", so the calculator is waiting for a name to be entered. The flashing [A] symbol indicates that "Alpha lock" is on – thus we can name this list "DAY" simply by pressing the appropriate keys where the letters appear. ([x^{-1}] [MATH] [1])

The numbers 1, 8, 15, 22 etc. form a sequence of the type: {$7x - 6$} where x takes values from 1 to 53. This information is entered by pressing: [2nd] [LIST] [►] [5] (you will notice that the sequence begins to appear at the bottom of the screen) and then [1] [X,T,Θ,n] [–] [6] [,] [X,T,Θ,n] [,] [1] [,] [5] [3] [)] followed by [ENTER]



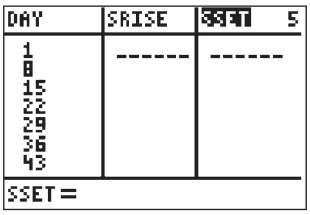






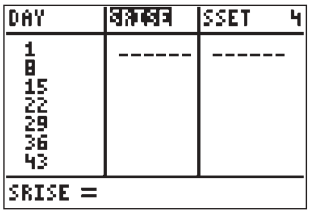
If we now try to produce a graph of the data, it will become obvious that something is not quite right. The graph results from plotting list 1 (Sunrise) against DAY.

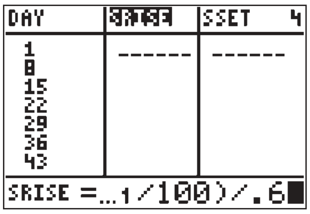
What we have failed to do, of course, is to convert our "24-hour clock" times into decimal numbers – so that, for example the time 452 means 4 hours and 52 minutes, which is 4.8666… hours.

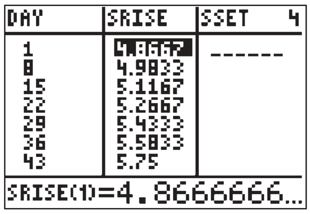


Again we'll use the calculator to do all these conversions for us. Firstly we'll name a new list to place the adjusted sunrise times and another for the sunset times. Press [►] (and [▲] if necessary) so that L3 is highlighted and press [2nd] [INS]. Name this new list SRISE (note that the maximum number of characters we can use in the name is 5). Repeat this process and name another new list SSET.

To convert the time of 452, we need to take the 4 (which on the calculator is the *integral part* of 452/100) and then add the *fraction part* of 452/100 divided by 0.6. The appropriate calculator commands are found under the NUM sub-menu of the MATH menu – but we'll do the calculations within the lists. Press the arrow keys if necessary so that "SRISE" is highlighted. We'll now enter a formula which will take all the sunrise times (which are in our list L1) and convert them into decimal times (in hours) within the SRISE list.
Press MATH ▶ 3 2nd 1 ÷ 1 0 0) ÷ MATH ▶ 4 2nd 1 ÷ 1 0 0) ÷ . 6 ENTER



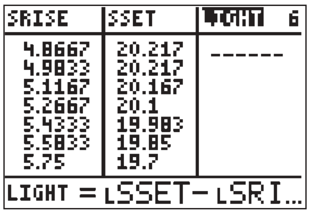


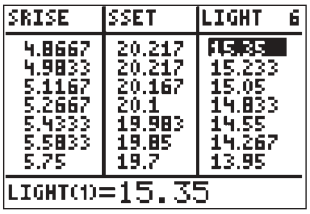


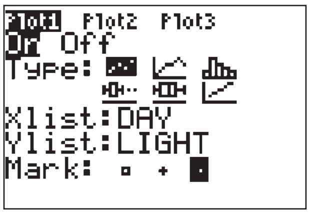
Use the same process to convert all the sunset values into decimals.

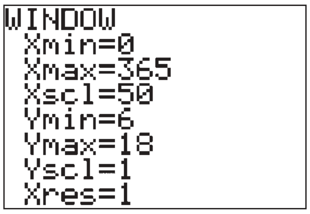
Our next stage is now to find the time of daylight, which we will assume is the time between sunrise and sunset.

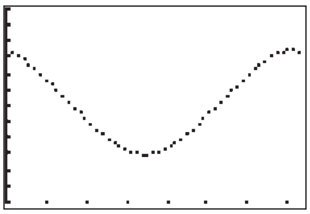
Create a new list called LIGHT using similar methods to those above. While LIGHT is highlighted, press 2nd [LIST], scroll down (using ▼) to the SSET list and press ENTER [OR simply press the number next to SSET if relevant]. Next press −, then 2nd [LIST], then scroll down (using ▼) to the SRISE list and press ENTER [OR simply press the number next to SRISE if relevant]. Finally, press ENTER .

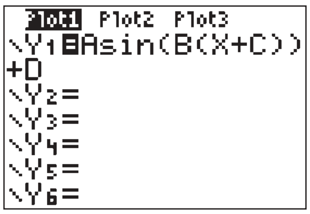










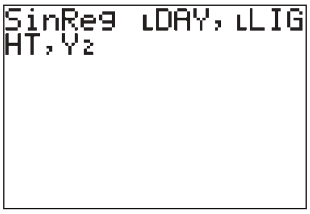


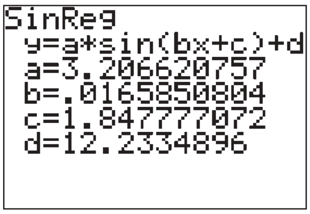
Finally, we'll produce a scatterplot of LIGHT against DAY – that is, a graph of hours of daylight plotted against day of the year. Press 2nd [STAT PLOT] 1 ENTER . This turns on the first of three available statistical plots. Press ▼ ▼ 2nd [LIST], scroll down to the DAY list and press ENTER . Now press ▼ 2nd [LIST], scroll down to the LIGHT list and press ENTER . Press ▼ ▶ ▶ to use a simple "dot" to mark each point (the other two options are not good choices for the number of points we are plotting). Next, press WINDOW and change the values to those shown below. After that, press GRAPH and you will get a screen similar to that shown.

Our next task is to fit a sine curve to these points. Recall that the curve $y = \sin x$ has period 2π, amplitude 1, is centred (vertically) and has its "first" zero at 0. If the curve is modified to the general form $y = A \sin(B(x + C)) + D$ then it now has period $2\pi/_B$, amplitude A, is centred (vertically) at D, and is translated C units to the left (or $-C$ units to the right).

Press Y= and then press ALPHA MATH SIN ALPHA APPS (X,T,Θ,n ÷ ALPHA PGRM)) ÷ ALPHA x^{-1}

Now press 2nd [QUIT] to return to the home screen. Our task is now to determine the values of *A, B, C* and *D* so that our sine curve gives a reasonable fit to our plotted points. To do this, simply enter a number, press STO→ and then *A* (using ALPHA MATH) or *B* (using ALPHA APPS) or *C* (using ALPHA PGRM) or *D* (using ALPHA x^{-1}) and ENTER. You can then press GRAPH to see how well your graph fits and press 2nd [QUIT] to return to the home screen to modify your values as necessary.





Extensions:

1. Use the sine regression function of the calculator to have it find the sine curve of 'best fit'. On the home screen press [STAT] [►], scroll up or down to find "SinReg" and press [ENTER]. Now press [2nd] [LIST], scroll down to DAY and press [ENTER], press [,], press [2nd] [LIST], scroll down to LIGHT and press [ENTER], then press [,] [VARS] [►] [1] [2], and finally [ENTER]. The final part of these instructions pastes the equation found into Y2 so that it can be plotted.

   You could now press [GRAPH] to see how well this curve fits the data. How does the calculated equation compare with yours?

2. Find sine curves to fit the SRISE and SSET curves. What similarities and differences are there between the equations of these curves and the LIGHT curve? What features of the equations for the SRISE and SSET curves allow us to subtract one from the other and still obtain another 'simple' sine curve (for LIGHT)?

3. Any time you use the calculator to find a regression equation, it automatically generates a list of 'residuals', which are the differences between the actual values you have plotted and the calculated values from the regression equation. This list can be found by pressing [2nd] [LIST] and scrolling down to RESID. What do you find if you plot RESID against DAY? Are any of LIGHT, SRISE and SSET really simple sine functions?

4. Use one of the given web sites to find the times of sunrise and sunset for other locations. How do the sine functions vary if you compare two sites with the same longitude but different latitudes? How do the sine functions vary if you compare two sites with the same latitude but different longitudes (but still within the same time zone)?

Sunrise and Sunset Times in Christchurch, 2005

Using Latitude 43°32'S, Longitude 172°38'E and Zone Time GMT+12

Day	CrudeS	CrudeS	Srise	Sset
1	452	2013	4.86667	20.2167
2	453	2014	4.88333	20.2333
3	454	2014	4.9	20.2333
4	455	2013	4.91667	20.2167
5	456	2013	4.93333	20.2167
6	457	2013	4.95	20.2167
7	458	2013	4.96667	20.2167
8	459	2013	4.98333	20.2167
9	500	2013	5	20.2167
10	501	2012	5.01667	20.2
11	502	2012	5.03333	20.2
12	504	2012	5.06667	20.2
13	505	2011	5.08333	20.1833

NB. Full table not shown.

Sunrise
Sinusoidal Regression
Rise(x) = 1.64846*sin(.01638*x+-1.18261)+6.35173

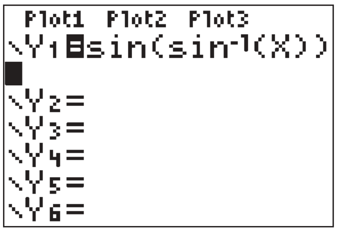
Sunset
Sinusoidal Regression
Set(x) = 1.61003*sin(.016094*x+1.85305)+18.658

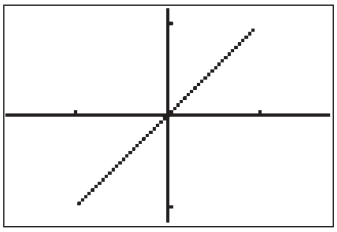
Daylight (Sunset – Sunrise)
Sinusoidal Regression
Daylight(x) = 3.20905*sine(.016562*x+1.85192)+12.2386

Exploring Sin and Arcsin Functions

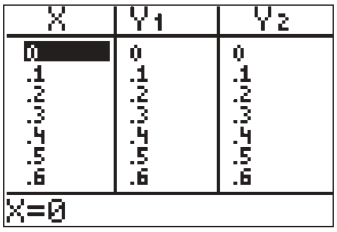
By Kwee Tiow Choo, Hwa Chong Institution, Singapore

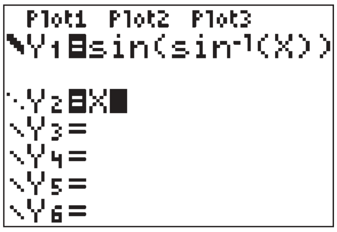
This is a good exercise for exploring composite functions and the reinforcement of principle range of trigonometric inverse functions. If $f(x) = \sin(x)$ what does $f(f^{-1}(x))$ equal, what about $f^{-1}(f(x))$? Is this the same as $f(x).f^{-1}(x)$? What if $f(x) = \cos(x)$ or $f(x) = \tan(x)$?

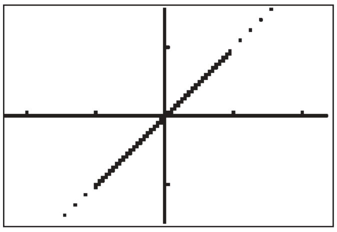




The graph produced appears to be the line y = x with a restricted domain. To test this hypothesis visually, students can draw the graph of y = x over the top of $f(f^{-1}(x))$.

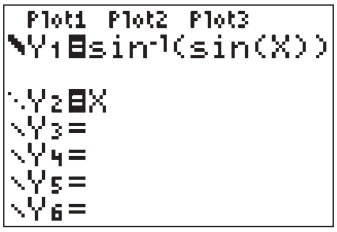


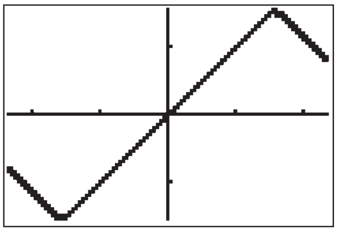


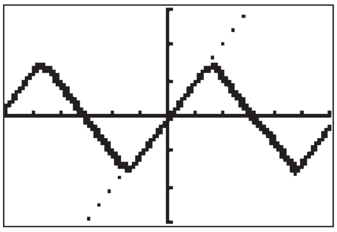


- The graph of $f(f^{-1}(x))$ has been made bold so it can still be seen.
- The graph of y = x has been turned into a dotted line.
- The table of values confirms $f(f^{-1}(x)) = x$

The first part of the question has been 'solved'. It seems to be true that $f(f^{-1}(x)) = x$. Students can investigate the same thing for cos(x) and tan(x). As expected, the cos(x) investigation reveals the same graph, no surprises. The graph of $\tan(\tan^{-1}(x))$ brings in the question of domain. Students should look to the end points of $\sin(\sin^{-1}(x))$ and $\cos(\cos^{-1}(x))$. This leads into an exploration of the domain and range of $f(x)$ and $f^{-1}(x)$, particularly if students are then asked to investigate $f^{-1}(f(x))$. Starting with sin(x) once again…







The graph still appears to be the line y = x, however, it diverges from this after $x = \pi$. Ask students to comment on the graphs, you will be surprised by the many interesting answers from them.

Getting to Know Your Robot

By Peter Fox

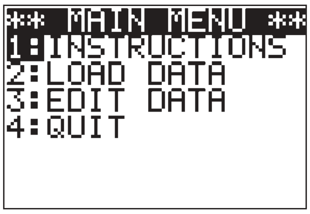
Introduction

There are examples of robots all around us in our everyday lives. Washing machines, air conditioners, cars… all contain robotic devices. Robots are no longer the domain of science fiction. Microprocessors are now extraordinarily cheap and many of them can be reprogrammed using computer software, or in this case, a graphical calculator. The robot used in this investigation has been programmed to accept commands from a graphical calculator. An air conditioner can be programmed to maintain a room at a given temperature. The air conditioner doesn't *understand* temperature, it understands voltages. A calibration is required to determine the status of an electronic component for given temperatures. In this task, you are required to calibrate the commands given to the robot with a physical distance.

Equipment

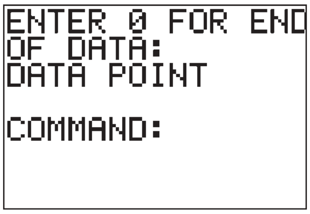
TI-83/TI-84 Plus/TI-84 Plus graphical calculator
Picblok ComminiCATOR robot
Unit to unit calculator cable
TIROBOT2 – calculator program

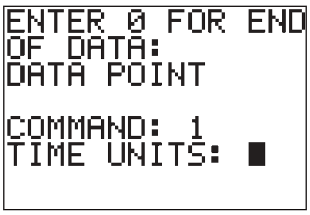
Getting Started

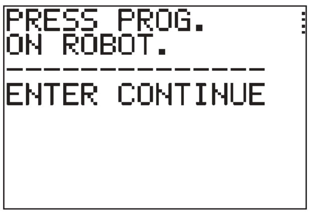


- Load the TIROBOT2 program onto your calculator.
- Run the program…
- Switch the Picblok robot on
- Connect the robot to the calculator via the unit to unit cable (and adaptor)

> In this activity Command 1 will be used. Command 1 is an instruction that makes both the robot's wheels rotate at the same speed and in the same direction.







- Select option [3] from the Main Menu.
- Enter a 1 (one) for the command.
- Enter 50 (fifty) for the time units. This will switch both servo motors on for 50 'units' of time.
- For the second data point, enter 0 for the command and 0 for the time units. This tells both the calculator program and the robot that the end of instructions has been reached. Once these values have been typed into the calculator the program returns to the main menu.
- From the Main Menu select option [2].
  …Load Data
- Press the Program button on the robot.
  The RED LED indicates the robot is now in 'Program' or 'Learn' mode.
- Press [ENTER] on the calculator and the commands will be sent into the robot.
- Disconnect the robot from the calculator.
- Press the Run button on the Robot.
  The Run button is between the buzzer and the Program button.

Task

Now that you have seen how to make the robot move, your task is to create a calibration for the robot. Your measurements must be accurate. You should test your calibration rule a number of times before commencing the final mission. For the final mission your teacher will place a target a measured distance away. You have one shot to hit the target. Your robots proximity to the target will determine your score.

Measurements and Strategy

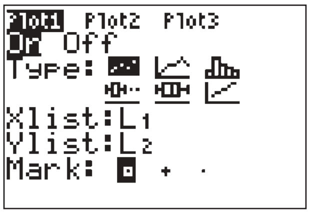
To help with the investigation record your findings in the table below.

Time Units (Entered on Calculator)	Distance Travelled (by Robot)
50	

You are not restricted to the number of measurement spaces provided here.

Your measurements will be used to help determine a relationship, so keep your time unit values simple.

Time units over 250 are not accepted by the robot. To overcome this, enter two command one's with time values of say 150 each. The result will be a total time unit equivalent to 300.



Finding a Relationship

Your calculator can now be used to find a relationship between the time units and distance traveled. Clear the calculators lists by pressing 2nd [MEM] – Option [4] then press ENTER.

To enter the data you have collected into the calculator, press STAT and select option [1] – Edit. Type your *time unit* values into List 1 and the distances into List 2.

To draw a graph of your data press 2nd [Stat Plot] followed by ENTER to edit the first plot set up. Match the settings shown opposite.

Press ZOOM and select option [9] to see a graph of your data.

1. What sort of relationship do you think exists between the data?
2. Write down a *general* rule for this type of relationship.
3. Determine the rule for your data. Write down your rule and explain how your rule relates to the movements of the robot.

Testing your Relationship

How well does your relationship predict the movement of your robot?

4. Write down three distances. (Use a range of distances between 0.1m and 2m.) Use your rule to determine what value you must use for time units to achieve the distances you have chosen. Show all your calculations.
5. Test your distances using the robot and write down your results. Discuss the accuracy of your results. If you are not happy with your results you can collect more data or check your rule against your existing data.

Your teacher MUST supervise the testing phase.

Evaluation Time

Your teacher will now place the target and provide you with a starting point and overall distance.

6. Use your rule to determine how many time units will be required to travel the distance.

Program your robot to travel the required distance and test your outcome.

Challenging Questions

7. Sadly, your robots wheels have just fallen off, and just before your evaluation! The wheels can be replaced, but unfortunately the replacement wheels are twice the diameter of the wheels that you have been using.
   a) How will this change your graph?
   b) Write down your new calibration rule.
8. Find a relationship between the values used for Command 3 and the number of degrees the robot turns. Use the information from this investigation and the original to program the robot to draw:
   a) A square (Side lengths 30cms)
   b) An equilateral triangle (Side lengths 40cms)

Another Piece of Pi, Monte?

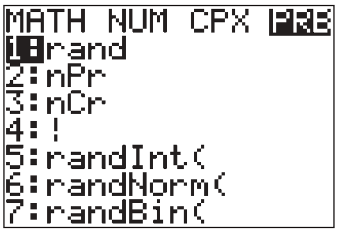
by Carol Moule (South Australia)

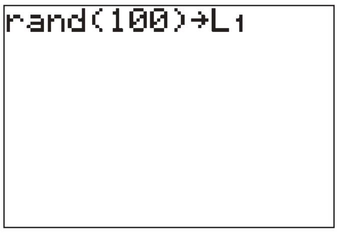
This activity uses random numbers, lists and a test function to calculate the number of randomly scattered points in a unit square which are on or below a curved line in the square. While it demonstrates several different functions on the GC it can also lead to an estimate of pi. [It is similar to counting points inside a circle, but the result will not be known to most students until it is actually found and shown to be useable to estimate pi.]

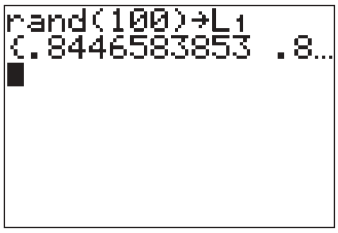
To understand why the answer is π requires a knowledge of integration, but this is an extension of the basic activity for more advanced students. Students can be shown how to find the area under a curve easily so they will understand that the proportion of points below the curve from the data set will be an estimate of the actual answer. The graphics calculator allows many such opportunities to introduce ideas and concepts much earlier than we used to be able to do, so activities such as this one will leave some residue of new ideas behind ready to be reactivated later when it is more appropriate.

Step 1 Produce 100 random numbers and store in list 1.

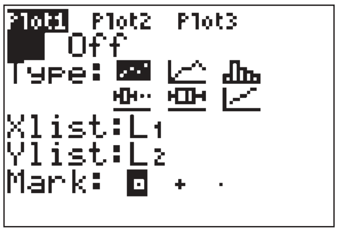
Step 2 Using 2nd entry, repeat the random numbers and store in L_2.
In this case, use 4*rand(100) STO▸ L_2.
The first list is a set of 100 random numbers between 0 and 1. The second set of numbers is a set of random numbers between 0 and 4. Together, these two lists will be plotted with L_1 on the x axis and L_2 on the y axis.

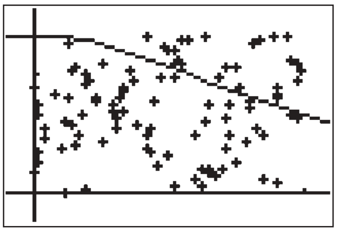


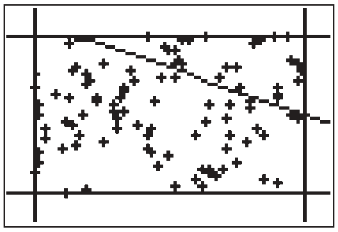




Step 3 Produce a scatter plot of L_1 v L_2
Zoom 9 will fit it to the screen, provided all other plots including any functions are off.





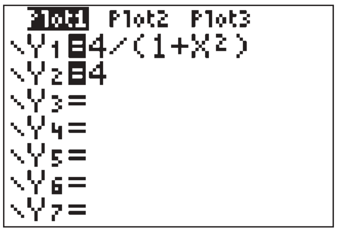


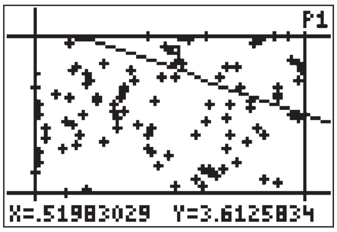
[If desired a vertical line at approximately x = 1 and the function y_1 = 4 can be drawn around the points as shown.]

Step 4 A line at y = 2 should be drawn and the number of points above and below the line can be counted. It is reasonable to expect that the ratio of above to bottom points will be 1:1 by considering the areas of each part. Similarly a vertical line at x = 0.5 will divide the points into approximately two equal parts.

Step 5 Replace the horizontal line by y = 4x and count the points above and below the line.
Again the ratio of points above to points below will be 1:1 approximately.
Similarly, the ratio will be 1:1 for the line y = 4 – 4x .

Step 6 Now draw the function $y = \dfrac{4}{1 + x^2}$ over the points. Ask the students to guess the ratio in this case.

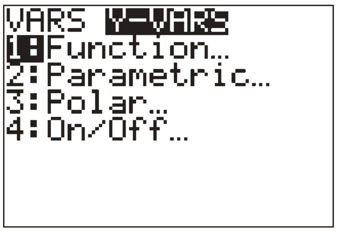


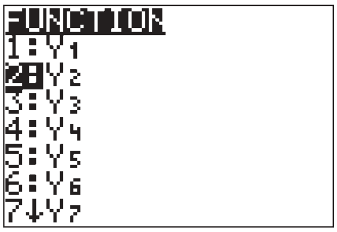


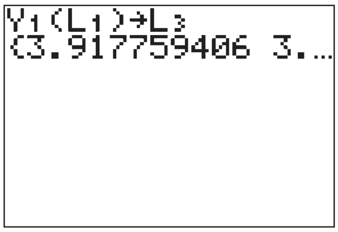
At this stage the number of points on or under the line could be counted but it is fun to use the GC further to ensure that all points are counted. This method that follows could have been used in the above examples of course.

Step 7 We now want to check which points on the diagram have y – coordinates (L_2 in this case) that are less than or equal to the function value for each x coordinate. So in L_3 we will calculate values of y for each x value in L_1 as shown.

To do this easily use the Y-VARS menu to find Y_1 and evaluate $Y_1(L_1)$ and store in L_3

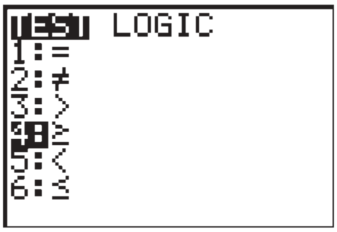


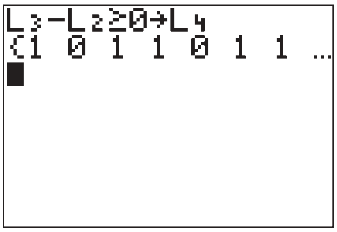


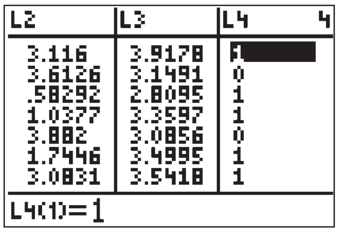


Step 8 Since we only want to know whether these values are either more or less than the random y-values we can calculate $L_3 – L_2$, but we only want to know how many points are actually on or below the curved line a test can be used...

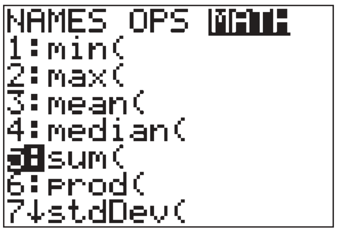
Since the test function delivers 1 if the test is true and 0 if it is not, the command $L_3 – L_2 \geq 0$ will return 1 if the point is on or below the curved line and 0 if it is above it, the result can be stored in L_4. Finally finding the sum of this list will count the required points.

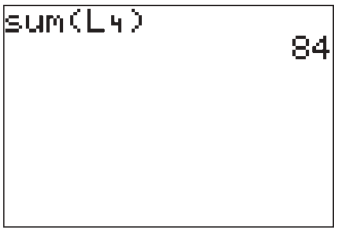






Now to add the list follow these screens in the STAT menu:

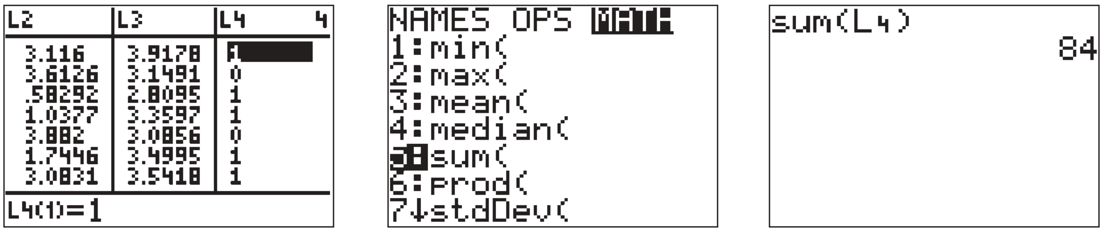




Now this suggests that for this set of data points, the proportion under the curve = 84/100 = 0.84. Multiply the value by 4 to get the approximate area under the curve. Ask the students why this value needs to be multiplied by 4.

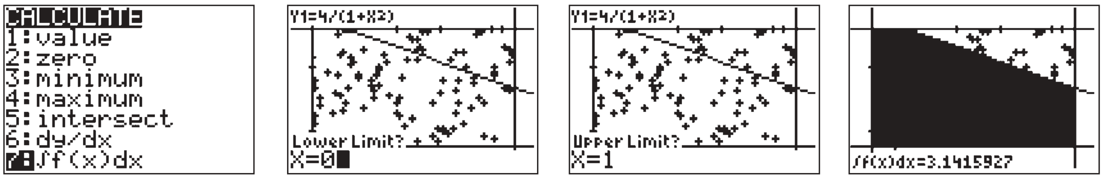
The data approximation can only be to two places of decimal since there are only 100 points, so more points would produce a better approximation. As more and more simulations are completed, the result approaches π. This can be achieved by the students either repeating the process around 10 times, compiling class results, or both!

[Remember that the students' calculators must all be 'seeded' differently so that different numbers are produced for the lists.]



Step 7 Why is it π ?

The area under the curve can be calculated by integration, and is found to be 3.1416



The area under the curve could be shown using the calculator regardless of whether the students were ready for this idea or not since it is just another calculator function, and some will remember it when it is needed in later years.

Step 8 Algebraically

Note: *The substitution used here is not obvious for most students, however, the approximate area appears to be equal to π. Students can suggest what type of substitution may lead to a calculated result of π. Trigonometric functions generally involve p and are therefore a good choice.*

Area under the curve = $\int_0^1 \frac{4}{1+x^2}\,dx.$

Let $x = \tan\Theta$, then $\frac{dx}{d\Theta} = \sec^2\Theta$ and $1 + \tan^2\Theta = \sec^2\Theta$, so by substitution,

$$\text{Area} = \int_0^1 \frac{4}{1+x^2}\,dx$$

$$= \int_0^{\frac{\pi}{4}} \frac{4}{1+\tan^2\Theta}\sec^2 0.d\Theta$$

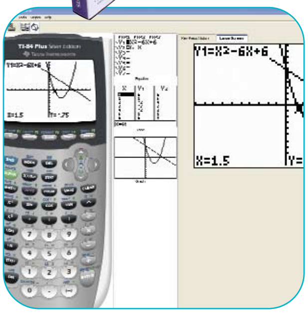
$$= \int_0^{\frac{\pi}{4}} 4d\Theta$$

$$= 4[\Theta]_0^{\frac{\pi}{4}}$$

$$= \pi$$

Step 9 Extensions to the same method to other functions.

If the function drawn is replaced by the parabola $y = x^2$, then $y = x^3$, x^4 and $x^{1/2}$ and counting the points each time an interesting result can be observed! The result can also be verified using the area/integration method.



TI-SmartView™ TI-84 Plus Emulator Software For Mac/PC

TI-SmartView™ emulator software is an easy-to-use, effective teaching tool. Based on the functionality of the TI-84 Plus family graphing calculators (and compatible with the TI-83 Plus Family), the TI-SmartView™ complements the classroom calculator use by projecting an interactive representation of the calculator, plus offers many unique instructional capabilities.

View3™ feature
The View3™ facility can simultaneously project multiple representations of graph, table, and equation screen-increasing student understanding of concepts and relationships.

Scripts
Preloaded demonstrations (scripts) help teachers increase their familiarity with the graphing calculator functionality-ideal for those just getting started with or expanding their use of the graphing calculators.

You can prerecord your own key press operation of the calculator for playback in class.

Screen Capture
Easily create and save multiple screen captures. Screens as well as Key Press histories can be copied into commonly used document software like Microsoft® Word or PowerPoint®.

Key Press History
As key are selected, key images and entire sequences can be projected to the class. This helps students follow and stay on track.

Easily integrates with existing projection systems and interactive whiteboards.

TI-89 Titanium Operating System v3.10

This operating system (OS) version is a recommended update for all TI-89 Titanium units. The new functionality includes domain and graphing improvements, solving inequalities, solving equations involving vectors, nth root and log to any base functionality, implicit derivatives and gradian angle measure.

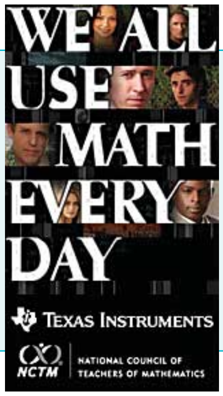
Steps to check your OS version:

1. Press **F1** on your TI-89 Titanium
2. Scroll down to **About**
3. Press **Enter**
4. You should see Advanced Mathematics Software Version 3.10
5. If you do not have OS version 3.10, you can download it FREE! By visiting **http://education.ti.com/us/product/apps/89tios.html**

Please note:

- Before you begin to install any new Apps or update your OS, be sure you have a new set of batteries in your TI handheld for optimum performance.
- Installing OS 3.10 will remove all data including preloaded Graphing Calculator Software Applications (Apps). Consult TI-Connect help for details on backing up RAM, archive and applications.

what's new



TI, in association with the National Council of Teachers of Mathematic (NCTM), Partners with "NUMB3RS," the Paramount Network Television Series for CBS, to launch an Innovative Math Education Program.

In partnership with CBS, and working in association with the National Council of Teachers of Mathematics (NCTM), TI has created an educational outreach program promoting the many uses of mathematics and supporting math teaching. The program includes TI and NCTM-developed maths education activities for teachers and students based on the 'NUMB3RS' TV show. The activities will be based on the mathematics presented in each episode.

"TI is proud to work with 'NUMB3RS' and NCTM to promote student interest in mathematics," said Melendy Lovett, president, Educational & Productivity Solutions, Texas Instruments. "TI has long worked with math and science educators, and we view our 'NUMB3RS' program as another way to help classroom teachers show students the real world relevancy of math."

The maths used in each episode of NUMB3RS is based on real FBI cases. Mathematics consultants work with NUMB3RS throughout production to ensure that the mathematics used to help analyse and solve crimes is real and accurate as depicted by FBI agent Don Eppes (Rob Morrow) who recruits his mathematical genius brother Charlie (David Krumholtz) to help the Bureau solve a wide range of challenging crimes.

The program was specifically designed to help students (and their parents) realise how relevant maths is to everyday activity and understand the importance the subject plays in their future success. By tying the maths used within each episode of NUMB3RS to classroom activities for teachers, teachers can increase student interest with these real-world examples. Each activity has been derived from the math used in the TV show and created by practicing classroom teachers and mathematicians especially for grades 7 – 12, and will be available at http://www.cbs.com/primetime/numb3rs/

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