
# The timely prediction

**CLASSROOM SCIENCE ACTIVITY TO SUPPORT STUDENT ENQUIRY-BASED LEARNING**

**This classroom-tested teaching plan uses the four innovations of the TEMI project, as detailed in the Teaching the TEMI Way (TEMI, 2015).**

You should read this companion book to get the most from your teaching. The **TEMI** techniques used in this teaching plan are: **1)** productive science mysteries, **2)** the **5E model** for engaged learning, **3)** the use of presentation skills to engage your students, and **4)** the apprenticeship model for learning through gradual release of responsibility. You might also wish to use the hypothesiser lifeline sheet (available on the **TEMI** website) to help your students document their ideas and discoveries as they work.

To know more about **TEMI** and find more resources **www.teachingmysteries.eu**

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**teachingmysteries.eu**

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# The timely prediction

## What's the mystery?

A random number is freely generated by the learners, only for the teacher to magically match it to a prediction about the current date or location.

### DOMAIN(S)

Mathematics.

### SUBDOMAIN KEYWORDS

Addition grids, tables, magic mathematical row column, matrix.

### AGE GROUP

**8** to **14** years old (with different levels of differentiation).

### EXPECTED TIME FOR THE MYSTERY

Approximate time for teacher preparation: **30 min**.

Approximate time in classroom: **40 min**.

### SAFETY/SUPERVISION

No safety precautions required.

**Disclaimer:** the authors of this teaching material will not be held responsible for any injury or damage to persons or properties that might occur in its use.

### PREPARATION AND LIST OF MATERIALS

» Paper
» Pens
» Grids of numbers prepared by teacher similar to those shown in this document
» Calculators

### LEARNING OBJECTIVES

Student will practise addition and subtraction skills. They will also explore number patterns and data structures such as matrices.

# Guidance notes for teachers

THE 5E MODEL

## Engage

CAPTURE STUDENTS' ATTENTION

Tell the students that you made a prediction a while ago specifically for today. Hand one of them a prediction on a folded piece of paper to read later.

Proclaim you had a dream about a truly random number that was chosen and you want them to create a truly random number now. You don't want their number to be influenced by anything in their minds already, so say that you brought some random number grids to help with the choices. They can pick any grid they like (see the grids at the bottom of this document).

Now they must choose four numbers on their chosen grid. To ensure there is no relationship between the numbers and that they are all random, they must not pick two numbers that share a row or column. So there should be four numbers: one from each row and one from each column. To make this clearer, whenever they pick a number, you can circle it and cross out the rest of the row and column.

Now the final stage in creating their random number is to add the four chosen numbers; once they find the total, they should look at the prediction. In this case, the total will always be 30.

## Explore

COLLECT DATA FROM EXPERIMENTS

Hand the students the tables and ask them some prompting questions:

» How did you know the total was going to be 30? (It will always be 30).

» What happens to the trick if I take one of the grids we used and swap around a couple of columns? What about if I swapped a couple of rows? The trick should still work.

» Can you design another grid where the total will always be 30?

» Are there any really obvious grids you could make where the total will definitely be 30? How about if the only numbers you used were 0 and 30? What about if you only used 15 and 0?

» How can you edit these obvious grids to make them more confusing? Could you swap any numbers around or split up the values in an interesting way?

» How do the rows in the tables compare to each other? Is this the same with the columns? Each row is a consistent amount more or less than the row above or below.

» Could this idea now help you make a more complicated grid where the result will also always be 30?

## Explain

WHAT'S THE SCIENCE BEHIND THE MYSTERY?

This trick works because the grids are actually addition tables. The numbers on the top and the far left that you add to get the sum for each square are invisible. I wonder if they can fill in the invisible row and column headings for the addition table? What do they notice about the column and row headings for each square? In each case, they add up to 30. Why is this important? By picking one from each row and column and adding them together, you are essentially adding all the row and column headings once; thus, you will end up with 30.

As an example, here is the first table with the addition grid numbers included.

The numbers in blue around the outside add up to 30.

The numbers in the grid form a simple matrix: this gives you the opportunity to discus what a matrix is and how it contains rows and columns of numbers.

It may be useful to introduce the mathematics with a simpler 2x2 grid. The first grid produces the sum 2+3+1+5=11. Students may find it easier to discover the pattern in such smaller grids. The second grid shows how the grid looks for a negative seed number: this grid produces the sum 3-2+1+5=7.

| + | 1 | 5 | 4 | 2 |
|---|---|---|---|---|
| 7 | 8 | 12 | 11 | 9 |
| 1 | 2 | 6 | 5 | 3 |
| 8 | 9 | 13 | 12 | 10 |
| 2 | 3 | 7 | 6 | 4 |

| + | 2 | 3 |
|---|---|---|
| 1 | 3 | 4 |
| 5 | 7 | 8 |

| + | -2 | 3 |
|---|---|---|
| 1 | -1 | 4 |
| 5 | 3 | 8 |

## Extend

WHAT OTHER RELATED AREAS CAN BE EXPLORED?

Can you now pick a new final number and create a grid that works for it? It doesn't have to be a 4x4 grid (yes, larger square grid sizes also work).

What about if we included negative numbers (it works for those too)?

Could we do something similar with multiplication (yes, it works for multiplication too, as it's a commutative operation like addition)?

Choose one of your grids. If you swap the rows around or swap the columns around or do both, you still get a working grid. However, you do not always get a working grid from this set of numbers; if you scrambled up your numbers completely, it probably wouldn't work. Can all workable grids with your chosen numbers be made just from row or column swaps? Or are there some other working grids you can make with these numbers that you can't get to with row or column swaps?

The lower grid shows how the grid looks with a negative seed number: this grid produces the sum 3-2+1+5=7.

| + | -2 | 3 |
|---|---|---|
| 1 | -1 | 4 |
| 5 | 3 | 8 |

Further ideas and information can be found at: www.deceptionary.com/aboutmatrices.html

## Evaluate

CHECK THE LEVEL OF STUDENT SCIENTIFIC UNDERSTANDING

Have students present their working grids or their findings on what makes a grid workable to the rest of the class.

THE 5E MODEL

## Showmanship

### TIPS ON HOW TO TEACH AND PRESENT THIS MYSTERY

Use the date or something related to the location as a predicition number. Then write "it is today's date" on the prediciton paper.

It is also good to really emphasise the randomness of the numbers being chosen and how we are going through this process to make sure that the number is completely random and not affected by earlier thoughts. The effect works independently, so enjoy the presentation and find your own style as a magician. Practise your performance a few times before doing it in public.

## GRR

### TEACHING SKILLS USING GRADUAL RELEASE OF RESPONSIBILITY

Tell the class they must add up four numbers from a chosen grid: one from each row and one from each column.

**Demonstrated enquiry (level 0):** have different grids on the board that will not produce 30 and model how the students should select one number from each row and column.

**Structured enquiry (level 1):** students should have a go at adding up four numbers to get the predicted number. They should then experiment a few times to see if this always happens and write down their theories about why this works.

**Solving the mystery:** students are led towards the explanation by using the given questions to lead them to the invisible addition grid.

## Resources

The necessary tables are at the end of this document. However, it would be a good idea to make your own with another number that is more relevant. Also see the "Magic of Computer Science Book 1":
www.cs4fn.org/magic/downloads/cs4fnmagicbook1.pdf

In the book (p. 53), the square of fortune gives a different presentation and resources on the computer science applications of the mathematical principle at the basis of this trick. For instance, they discuss its application to medical imaging.

The concept of a forcing matrix, more methods, and a spreadsheet for grid generation is given at:
www.deceptionary.com/aboutmatrices.html

# The timely prediction

STUDENT WORKSHEET

You have seen that the randomly chosen number was predicted at the very beginning.
You should investigate how this can be accomplished.

## Engage

WHAT'S INTERESTING?

**Task:** How can the teacher predict the result of your free choices?

## Explore

WHAT'S HAPPENING?

**Task:** What do you notice about the numbers in the grid?

Write down any patterns you see in the numbers.

What happens if you redraw a grid and swap two columns of numbers: does the trick still work?

What happens if you swap rows?

## Explain

WHAT'S CAUSING IT?

**Task:** Look at the example grid on the next column.

Imagine there are extra invisible numbers round the grid, represented here by '?'

What numbers would you need to put in each box with a '?' so that they add together to give the corresponding number in the grid?

| + | ? | ? | ? | ? |
|---|---|---|---|---|
| ? | 8 | 12 | 11 | 9 |
| ? | 2 | 6 | 5 | 3 |
| ? | 9 | 13 | 12 | 10 |
| ? | 3 | 7 | 6 | 4 |

For example, what two numbers add together to give 8?

It may be 7+1. Now look at the next box along, 12: what numbers would be in the '?' boxes? Remember that the '?' box for the top row must be either 7 or 1 to make the first 8.

Now consider 11: again, what two numbers add together to give 11? Remember again that one of them must come from either 7 or 1 to give the first 8 and the second 12.

Can you see a pattern developing as you work out all the missing '?' values?

## Extend

WHAT'S SIMILAR?

**Task:** Could you now pick a new final number and create a grid that works for this? It doesn't have to be a 4x4 grid.

What about if we included negative numbers?

Could we do something similar with multiplication? If so why?

## Evaluate

WHAT'S MY UNDERSTANDING?

**Task:** Create your own grid and make your own prediction. Present your version of the trick to the rest of the class

Tell the class about your findings on what makes a grid work.

| | | | |
|---|---|---|---|
| 10 | 5 | 6 | 9 |
| 7 | 2 | 3 | 6 |
| 11 | 6 | 7 | 10 |
| 12 | 7 | 8 | 11 |

| | | | |
|---|---|---|---|
| 10 | 3 | 9 | 2 |
| 13 | 6 | 12 | 5 |
| 12 | 5 | 11 | 4 |
| 11 | 4 | 10 | 3 |

| | | | |
|---|---|---|---|
| 6 | 10 | 8 | 7 |
| 5 | 9 | 7 | 6 |
| 3 | 7 | 5 | 4 |
| 9 | 13 | 11 | 10 |

| | | | |
|---|---|---|---|
| 5 | 7 | 13 | 6 |
| 8 | 10 | 16 | 9 |
| 2 | 4 | 10 | 3 |
| 4 | 6 | 12 | 5 |

| | | | |
|---|---|---|---|
| 11 | 8 | 5 | 9 |
| 8 | 5 | 2 | 6 |
| 13 | 10 | 7 | 11 |
| 9 | 6 | 3 | 7 |