

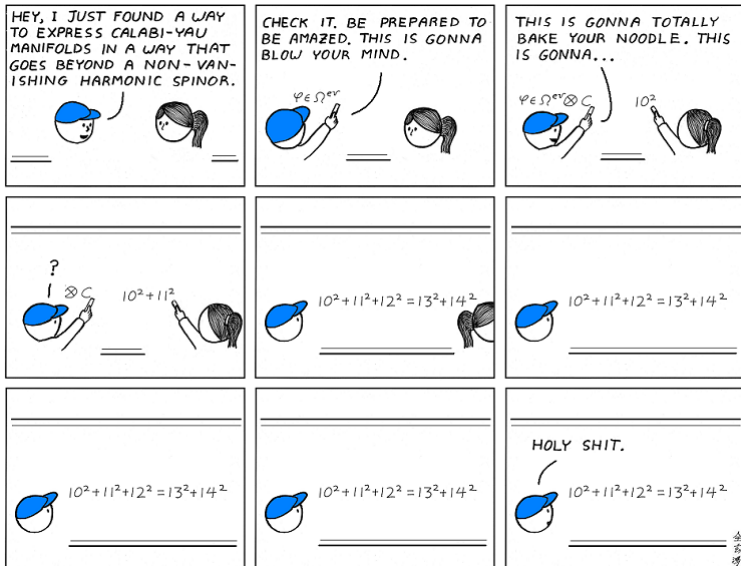
A Comic, a Painting, Triangles, and Squares

Francisco Albuquerque Picado

MathsJam, 18/11/2018

A comic

A comic



A painting



A painting

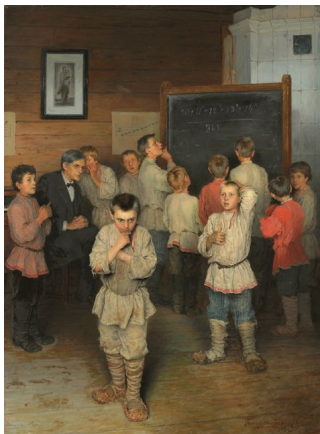


Figure: Mental Arithmetic. In the School of M. Rachinsky by "Nikolay Bogdanov-Belsky", 1896

A painting

A painting

For clarity, on the blackboard we can see:

$$\frac{10^2 + 11^2 + 12^2 + 13^2 + 14^2}{365}$$

An equation

So, is this unique?

An equation

So, is this unique? We need to solve

$$n^2 + (n + 1)^2 + (n + 2)^2 = (n + 3)^2 + (n + 4)^2$$

An equation

So, is this unique? We need to solve

$$n^2 + (n + 1)^2 + (n + 2)^2 = (n + 3)^2 + (n + 4)^2$$

If you do so, you get a unique positive answer:

An equation

So, is this unique? We need to solve

$$n^2 + (n + 1)^2 + (n + 2)^2 = (n + 3)^2 + (n + 4)^2$$

If you do so, you get a unique positive answer:

$$n = 10$$

Squares: How far can we go?

This was an example of a particular case of equations:

Squares: How far can we go?

This was an example of a particular case of equations:

- $n^2 = 0$
- $n^2 + (n + 1)^2 = (n + 2)^2$
- $n^2 + (n + 1)^2 + (n + 2)^2 = (n + 3)^2 + (n + 4)^2$
- $n^2 + (n + 1)^2 + (n + 2)^2 + (n + 3)^2 = (n + 4)^2 + (n + 5)^2 + (n + 6)^2$

Squares: How far can we go?

This was an example of a particular case of equations:

- $n^2 = 0$
- $n^2 + (n + 1)^2 = (n + 2)^2$
- $n^2 + (n + 1)^2 + (n + 2)^2 = (n + 3)^2 + (n + 4)^2$
- $n^2 + (n + 1)^2 + (n + 2)^2 + (n + 3)^2 = (n + 4)^2 + (n + 5)^2 + (n + 6)^2$

Observation 1:

k terms on the left side, $k - 1$ terms on the right side of the equality

Squares: How far can we go?

This was an example of a particular case of equations:

- $n^2 = 0$
- $n^2 + (n + 1)^2 = (n + 2)^2$
- $n^2 + (n + 1)^2 + (n + 2)^2 = (n + 3)^2 + (n + 4)^2$
- $n^2 + (n + 1)^2 + (n + 2)^2 + (n + 3)^2 = (n + 4)^2 + (n + 5)^2 + (n + 6)^2$

Observation 1:

k terms on the left side, $k - 1$ terms on the right side of the equality

Observation 2:

$$0 \in \mathbb{N}$$

Squares: How far can we go?

Squares: How far can we go?

These equations create these equalities:

Squares: How far can we go?

These equations create these equalities:

- $0^2 = 0$

- $3^2 + 4^2 = 5^2$

- $10^2 + 11^2 + 12^2 = 13^2 + 14^2$

- $21^2 + 22^2 + 23^2 + 24^2 = 25^2 + 26^2 + 27^2$

Squares: How far can we go?

These equations create these equalities:

- $0^2 = 0$
- $3^2 + 4^2 = 5^2$
- $10^2 + 11^2 + 12^2 = 13^2 + 14^2$
- $21^2 + 22^2 + 23^2 + 24^2 = 25^2 + 26^2 + 27^2$

Now look to the numbers on the left: 0, 3, 10, 21...

Squares: How far can we go?

These equations create these equalities:

- $0^2 = 0$
- $3^2 + 4^2 = 5^2$
- $10^2 + 11^2 + 12^2 = 13^2 + 14^2$
- $21^2 + 22^2 + 23^2 + 24^2 = 25^2 + 26^2 + 27^2$

Now look to the numbers on the left: 0, 3, 10, 21...

Does it ring any bell?

Some conclusion: Triangles

Some conclusion: Triangles

How did I solve this?

Some conclusion: Triangles

How did I solve this? I considered the general sum:

Some conclusion: Triangles

How did I solve this? I considered the general sum:

$$\sum_{i=0}^k (n+i)^2 = \sum_{i=k+1}^{2k} (n+i)^2$$

Some conclusion: Triangles

How did I solve this? I considered the general sum:

$$\sum_{i=0}^k (n+i)^2 = \sum_{i=k+1}^{2k} (n+i)^2$$

With positive solutions as the **even-ordered triangular numbers!!!**

Some conclusion: Triangles

How did I solve this? I considered the general sum:

$$\sum_{i=0}^k (n+i)^2 = \sum_{i=k+1}^{2k} (n+i)^2$$

With positive solutions as the **even-ordered triangular numbers!!!**

$$\Delta_{2n} = n(2n+1) = 0, 3, 10, 21, 36, 55, \dots$$

Some conclusion: Triangles

How did I solve this? I considered the general sum:

$$\sum_{i=0}^k (n+i)^2 = \sum_{i=k+1}^{2k} (n+i)^2$$

With positive solutions as the **even-ordered triangular numbers!!!**

$$\Delta_{2n} = n(2n+1) = 0, 3, 10, 21, 36, 55, \dots$$

In the end, should you trust me, this will be true.

$$55^2 + 56^2 + 57^2 + 58^2 + 59^2 + 60^2 = 61^2 + 62^2 + 63^2 + 64^2 + 65^2$$