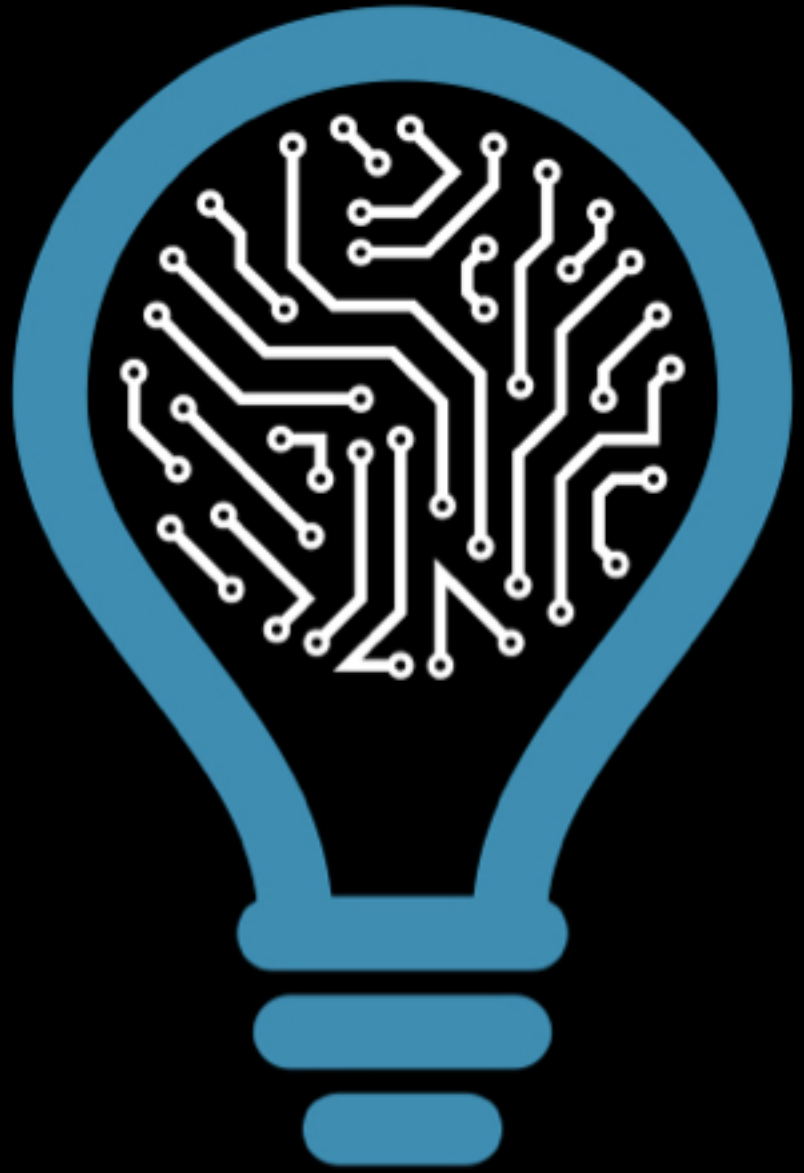
from knowledge production to science-based innovation



INESCTEC

INSTITUTE FOR SYSTEMS AND COMPUTER ENGINEERING, TECHNOLOGY AND SCIENCE

ENSICO and the new “Trivium” for computing in schools

J.N. Oliveira

HASLab

22 February 2023

INESCTEC

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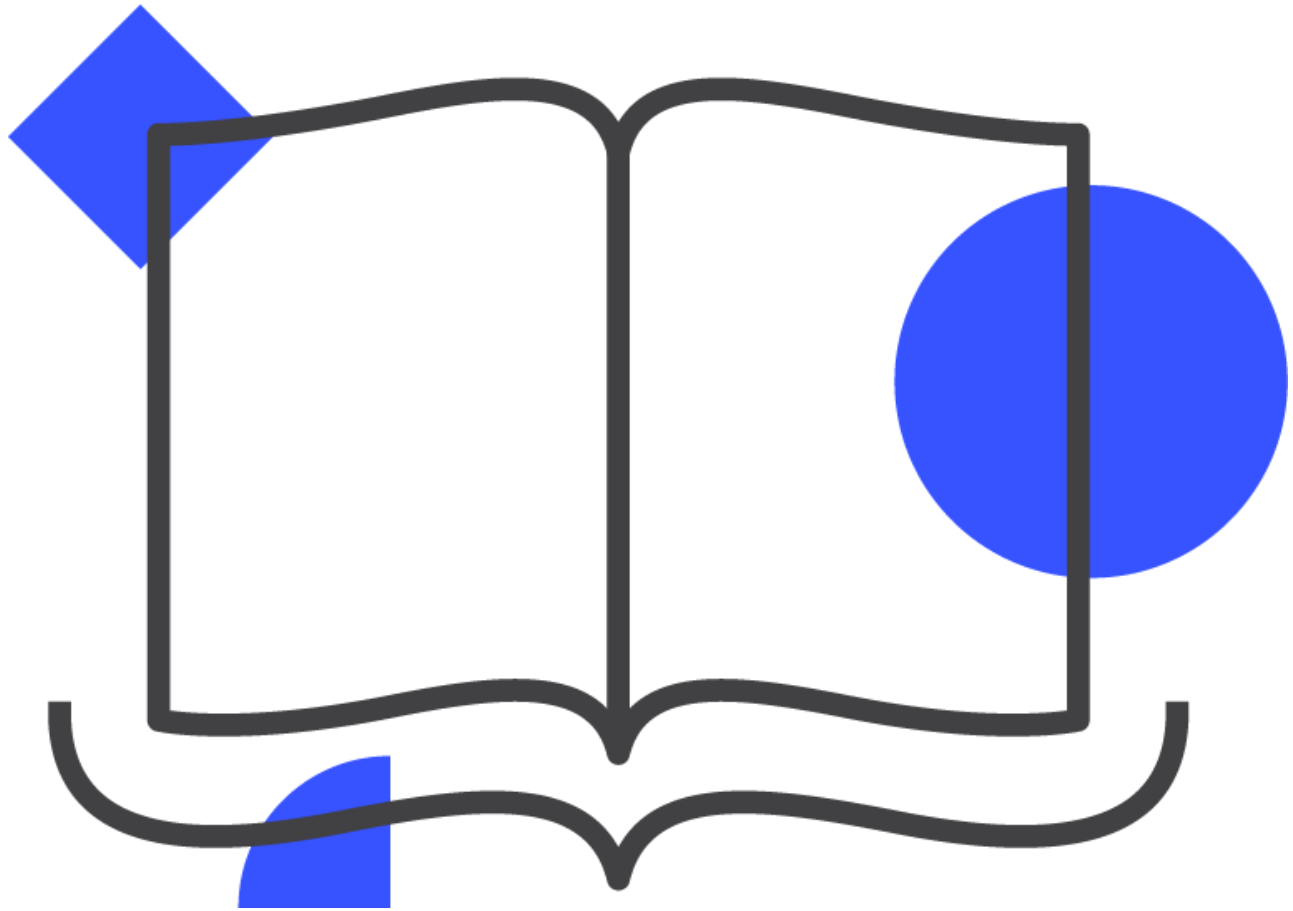
INESCTEC

- It is consensual that Computing should be introduced in schools (K12)
- Education approaches vary a lot!
- ENSICO privileges 'concepts' over technology (the '*unplugged*' method)
- Reporting on the INESC TEC/U.Minho/ENSICO partnership



Western Education Archeology

Since Classical Antiquity:

Trivium	➡️	Quadrivium
Grammar		Arithmetic
Logic		Geometry
Rhetoric		Music
		Astronomy

Trivium

Grammar ➡ Language

Logic ➡ Reasoning

Rhetoric ➡ Communication

Eventually...

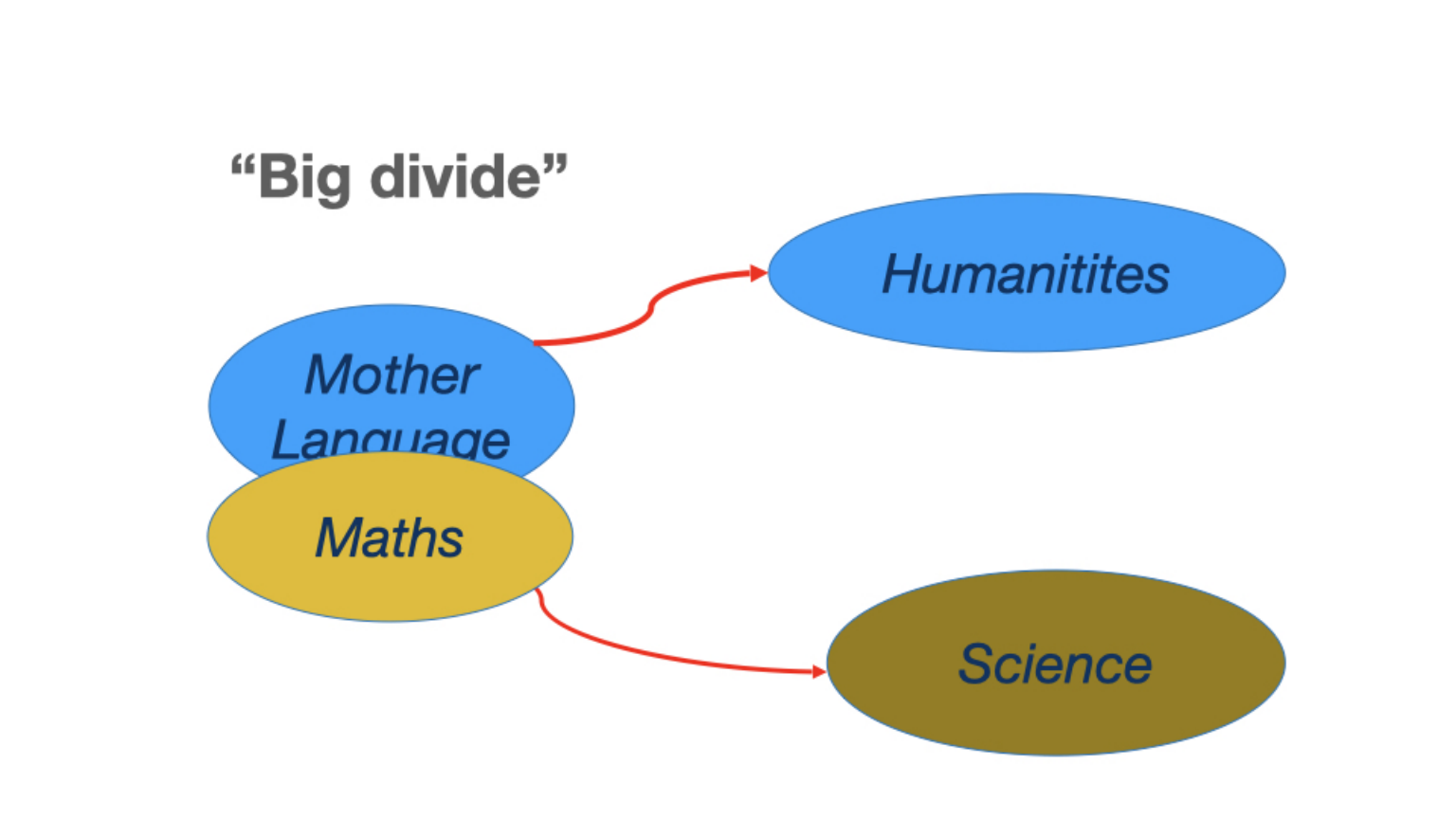
Grammar ➡️ Mother Language

Logic ➡️ Mathematics

Rhetoric ➡️ ...?

Humanities versus Science

- The **Big Divide**: “Art” or “Science”.
- Nefarious disjunction since the era of specialization.
- Hellenism and Renaissance "spirit" lost.



The Big Divide

Disastrous

> No reading, poor writing, weak speech articulation

Rhetoric lost...

> "*There is nothing more powerful than someone who is articulate and who can think and speak - it's power*"
> (J. Peterson)

IT gets in

Amazing advances in the last 50y enabled **digital communication**.

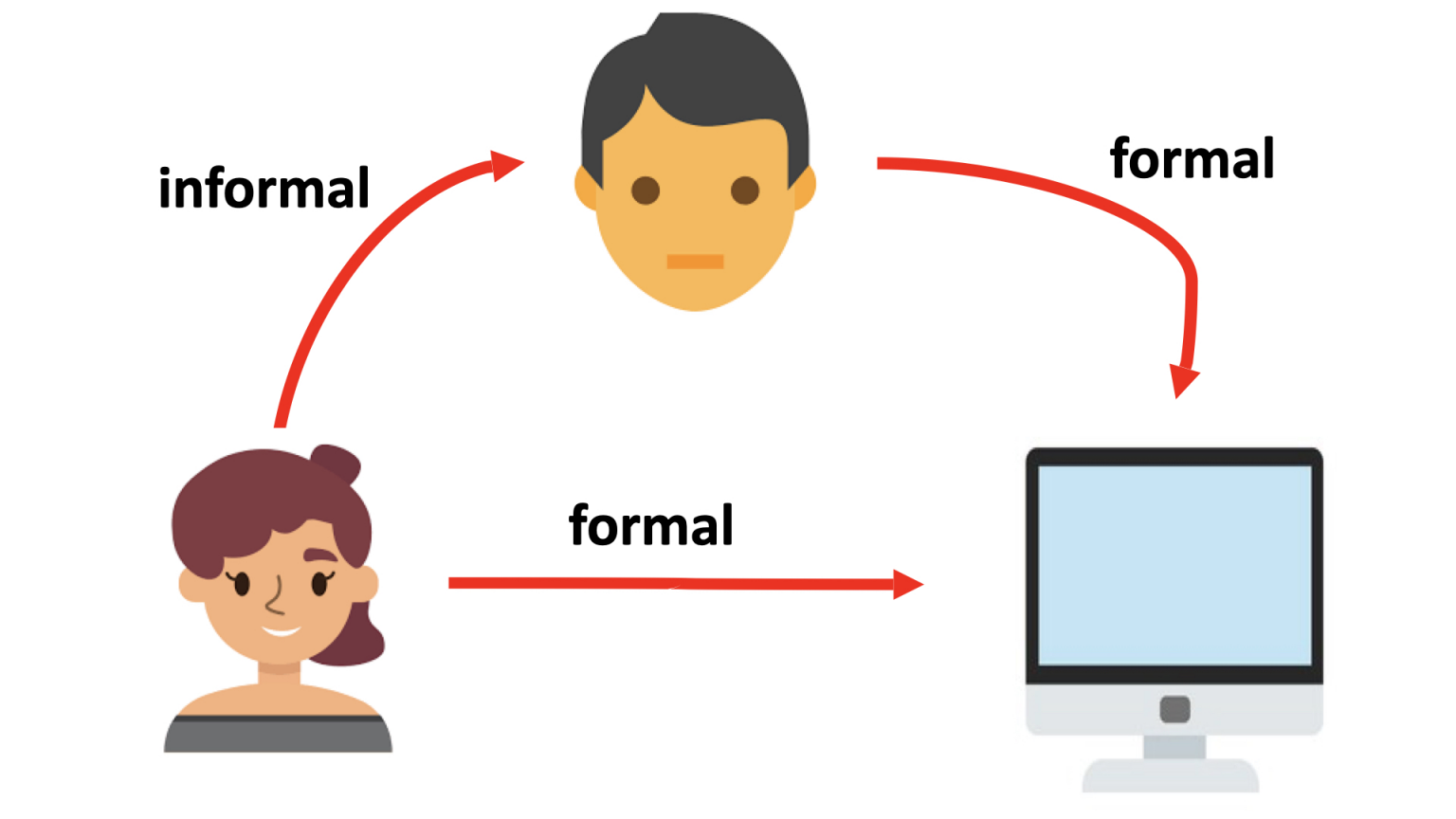
Rhetoric definitely lost?

Ups! Needed again, and of two kinds:

> **Human-Human**
> **Human-Machine**

Rhetoric goes heterogeneous

> Human-Human
> Human-Machine



The "New Trivium"

ENSICO - Computing in Schools

Aim:

> **Computing** as a new **core subject** in pre-university education (K12).

But...

> A **scientific** syllabus (not just technology) along with **Maths**, **Physics**, ...

ENSICO - Computing in Schools

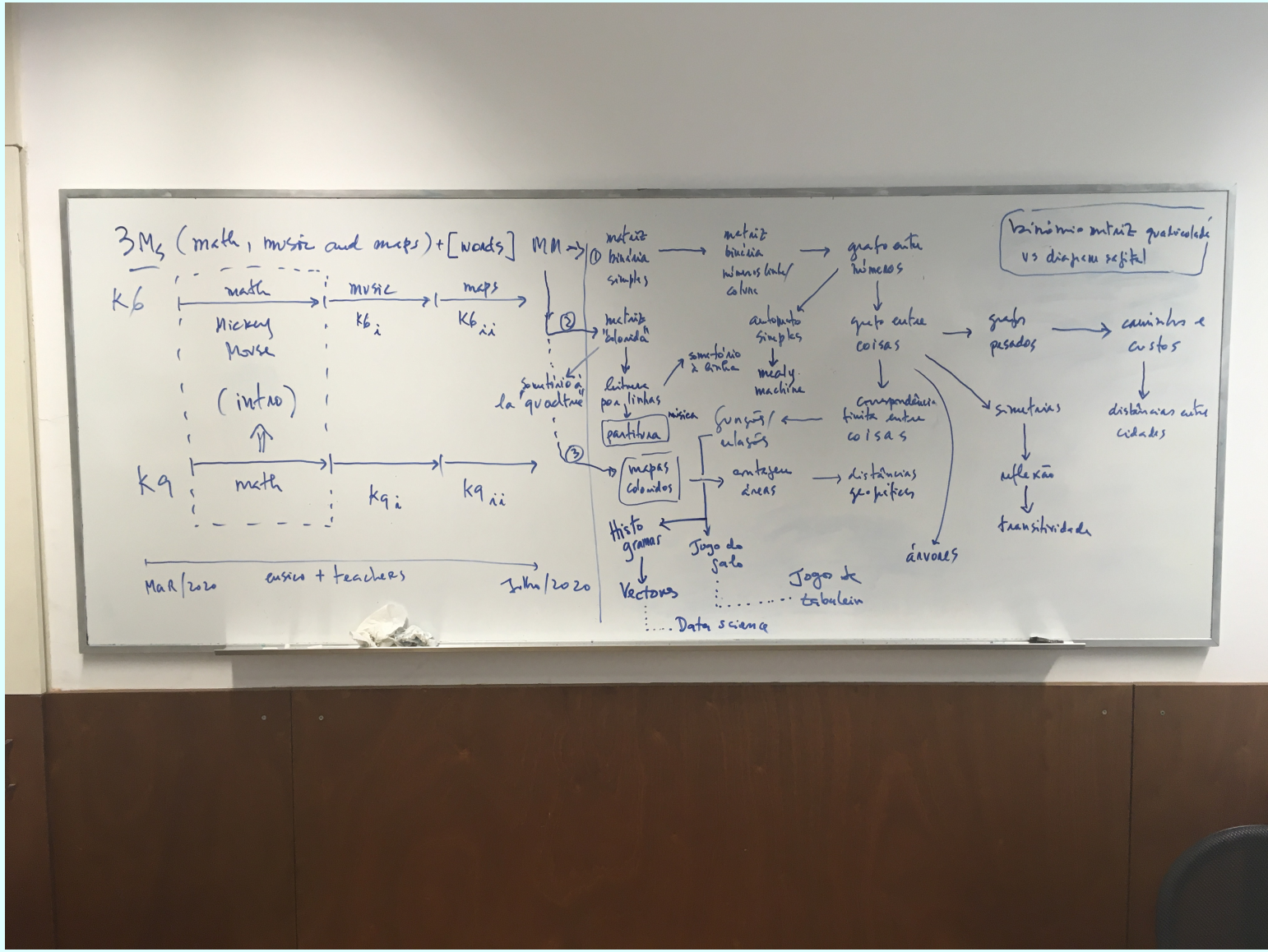
Pilot project

> Started in 2020, currently 100 classes (2200+ students), 1h/week.

ENSICO - Computing in Schools

Planning started 20-Feb-2020, just before the Covid pandemic...

2020 lockdown: set of webinars for school teachers.



ENSICO Sponsors

3 years later

Com o Alto Patrocínio
de Sua Excelência

Under the High Patronage of the
President of the Portuguese Republic

O Presidente da República

Público

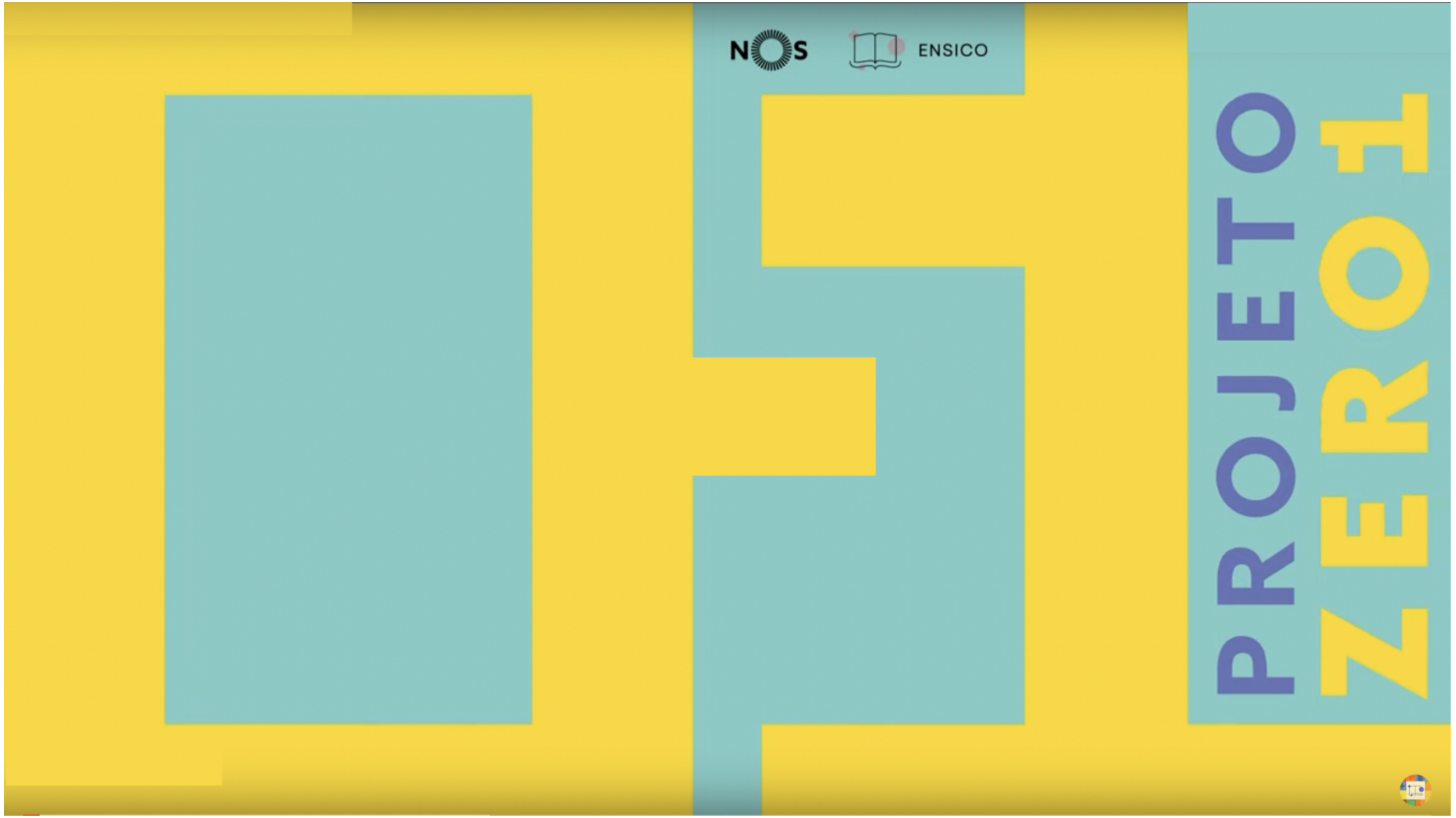
Público na escola

COMPUTAÇÃO NA ESCOLA

Códigos QR

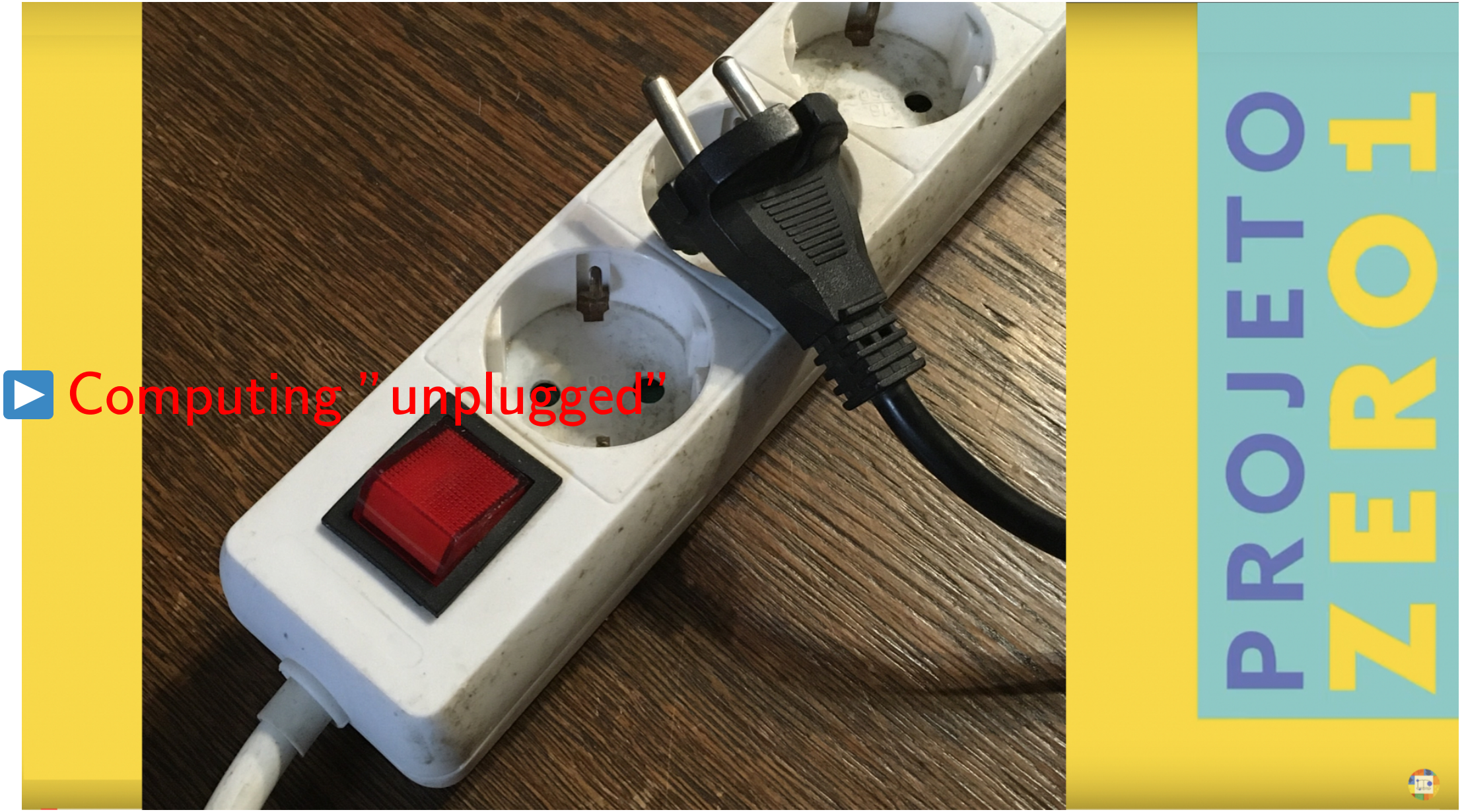
Nova invasão, agora de "seres" aparentemente mais sofisticados, com 3 grandes olhos e montes de pontinhos ou quadradinhos pretos aparentemente sem sentido. Até têm vindo a substituir os típicos menus nos restaurantes! Ouvimos dizer que são chamados "Códigos-QR". E que linguagem será a deles? Que segredos se esconderão no emaranhado de pontos e quadradinhos?

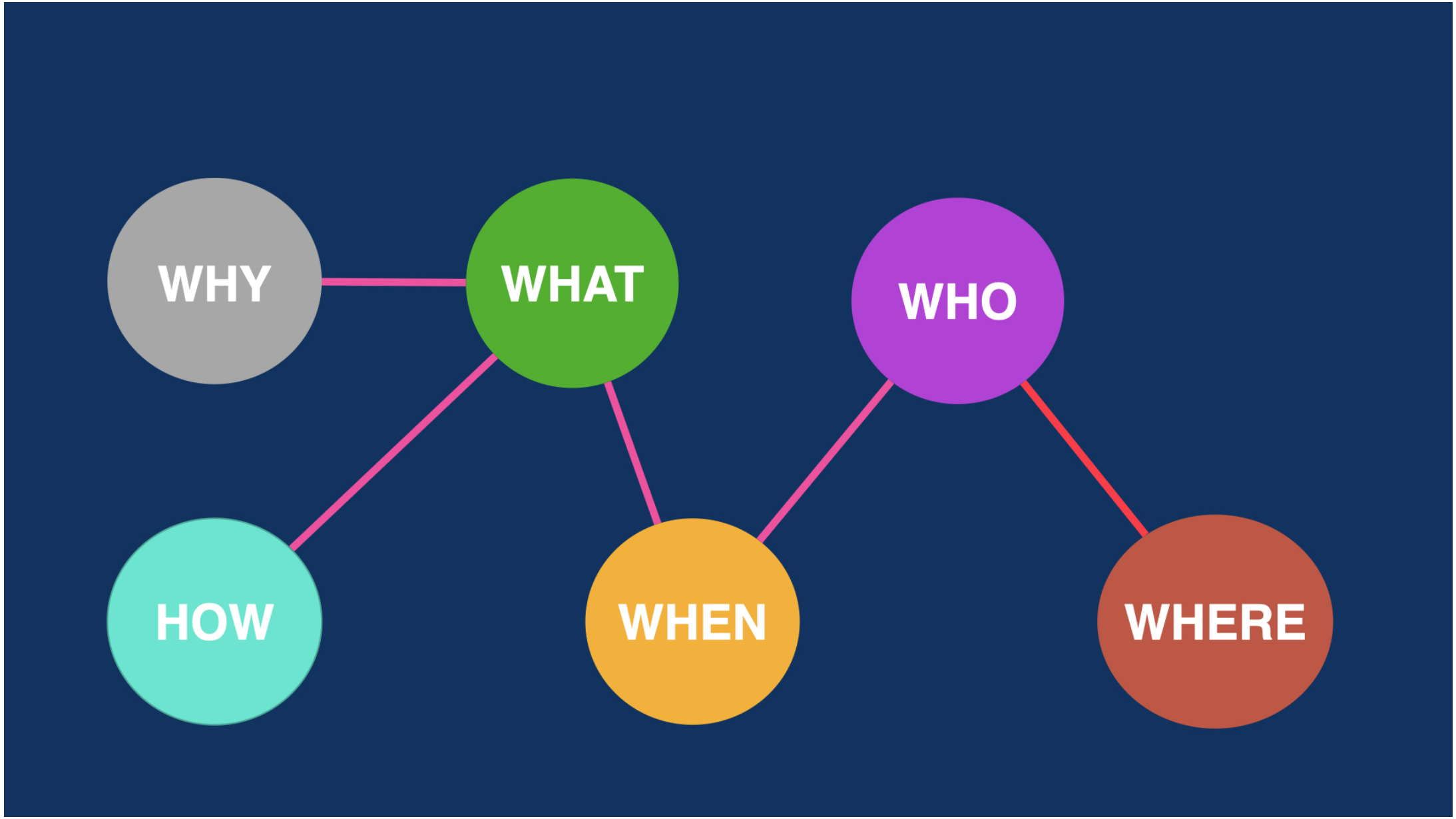

3:55 / 1:24:59


NOS
ENSICO
PROJETO
ZERO1

- EB Paredes da Beira
- EB Erverdosa do Douro

PROJETO ZERO


Computing "unplugged"
PROJETO
ZERO


WHY
WHAT
WHO
HOW
WHEN
WHERE

WHO

Invest in young, highly motivated tutors:

> Choose "Master Teachers" from outside the education system

Innovation

> by the **young** is fresh work
> by the **old** is error-fixing

WHO

ENSICO's '*secret weapon*'
😄

Brilliant mind

Boundless energy

Indomitable creativity

YouTube PT

MathGurl

@MathGurl • 107 mil subscritores

A matemática pode pôr-te maluco, mas

ALGORITMOS DE ORDENAÇÃO

11 mil visualizações • há 1 ano

PESQUISA BINÁRIA

3,9 mil visualizações • há 2 anos

RECURSIVIDADE EM AÇÃO

4 mil visualizações • há 2 anos

O MUNDO DOS AUTÓMATOS

5,1 mil visualizações • há 2 anos

SEIS GRAUS DE SEPARAÇÃO

3,3 mil visualizações • há 2 anos

AS HEROÍNAS DO ENIAC

2,2 mil visualizações • há 2 anos

WHERE

Welcomed the project straight away 💶

First sponsor

WHERE

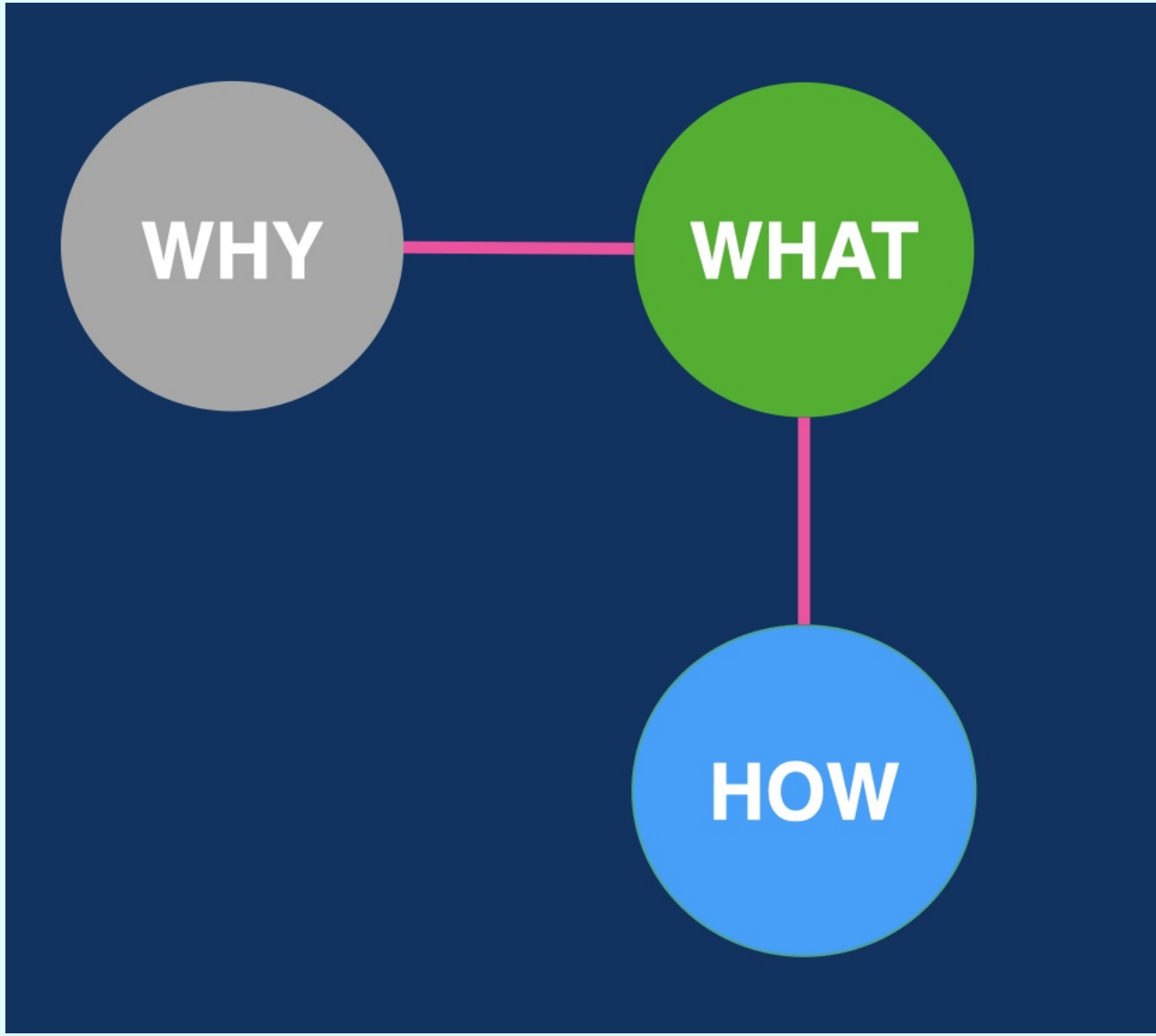
> 3 schools in town (2020/21)

HASLab gets in 👍

Contract ENSICO-INESC TEC

2021-2022, 31K

Syllabus contents and classroom material production



Golden principles

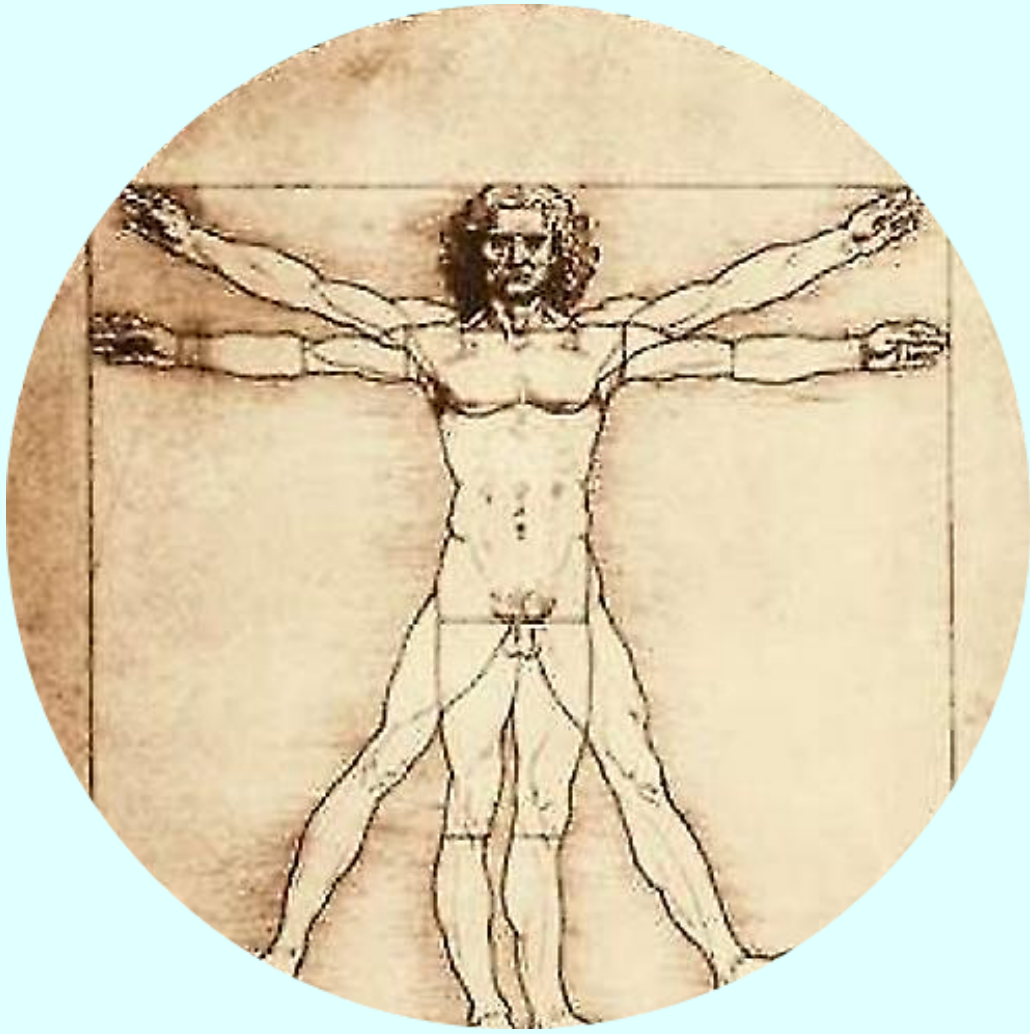
The computer is not the **aim**, it is the **means**.

> Avoid old-styled **ICT** academicism

Inwards teaching

> Always start from something the student **already knows**

History matters!



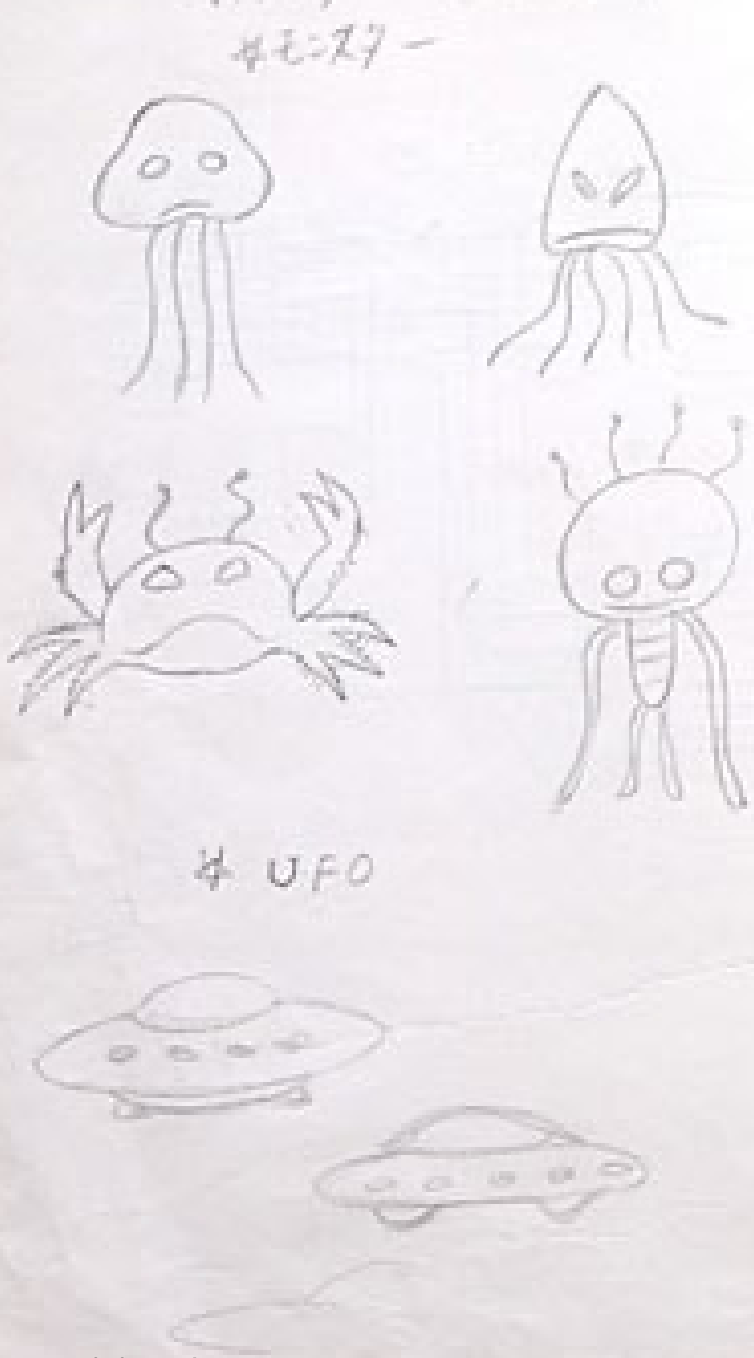
Example

Game | Space Invaders

Created by the Japanese Tomohiro Nishikado in 1978.

Became one of the most popular computer games ever 😄


SCORE 1,337
LIVES

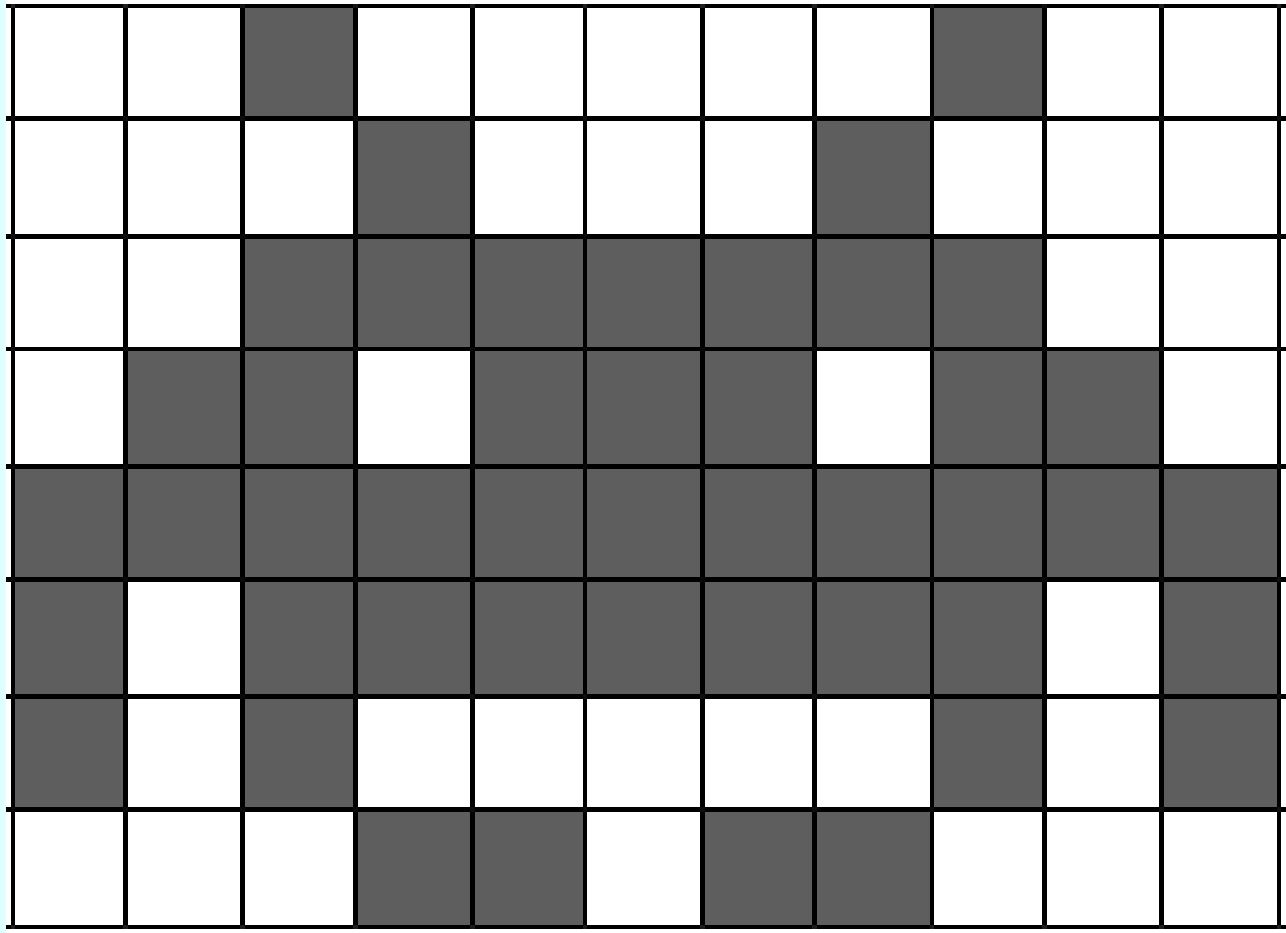

4 UFO

In our "computer"

If he did it, we can also do it! 😄

- **How does the computer memorize this? 🤔**

> Hint: it only knows about `0` and `1`.



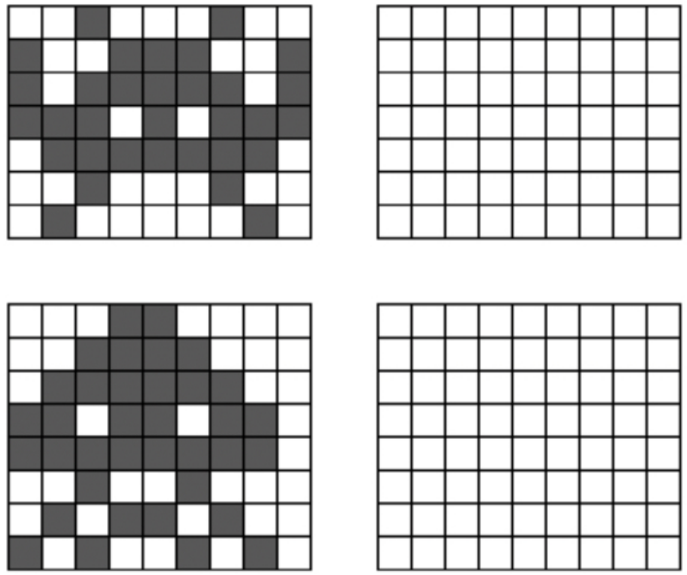
In a computer

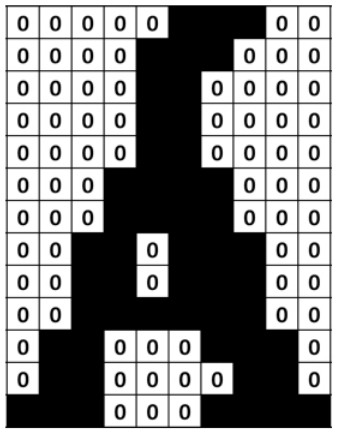
Black squares are `1`s, white squares are `0`s

Each square is called a pixel or bit (either a `0` or `1`).

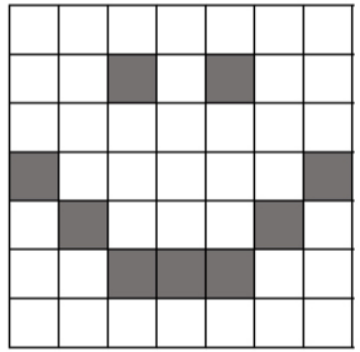
Rectangles of bits are known as bit maps.

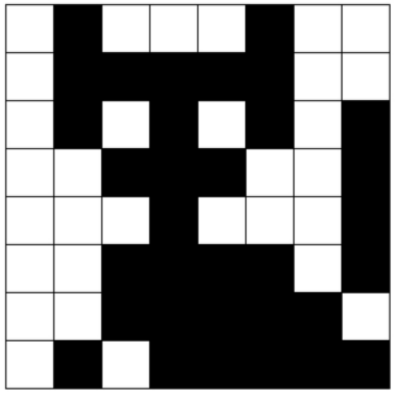
0	0	1	0	0	0	0	0	1	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	1	1	1	1	1	1	1	0	0
0	1	1	0	1	1	1	0	1	1	0
1	1	1	1	1	1	1	1	1	1	1
1	0	1	1	1	1	1	1	1	0	1
1	0	1	0	0	0	0	0	1	0	1
0	0	0	1	1	0	1	1	0	0	0

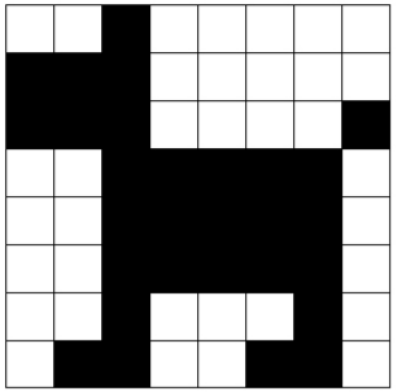


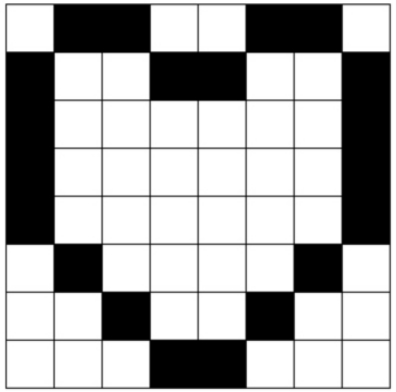


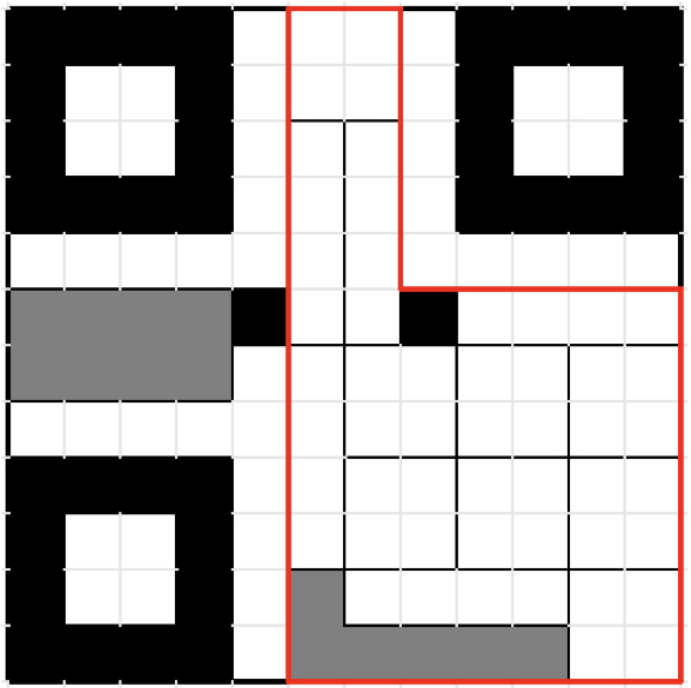
0	0	0	0	0	0	0
0	0	1	0	1	0	0
0	0	0	0	0	0	0
1	0	0	0	0	0	1
0	1	0	0	0	1	0
0	0	1	1	1	0	0
0	0	0	0	0	0	0

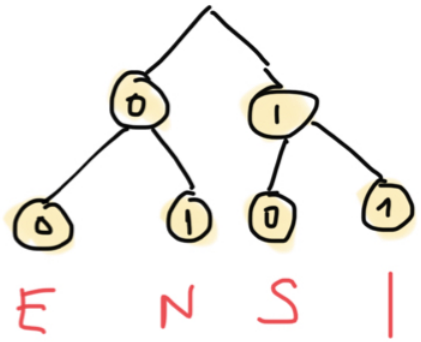


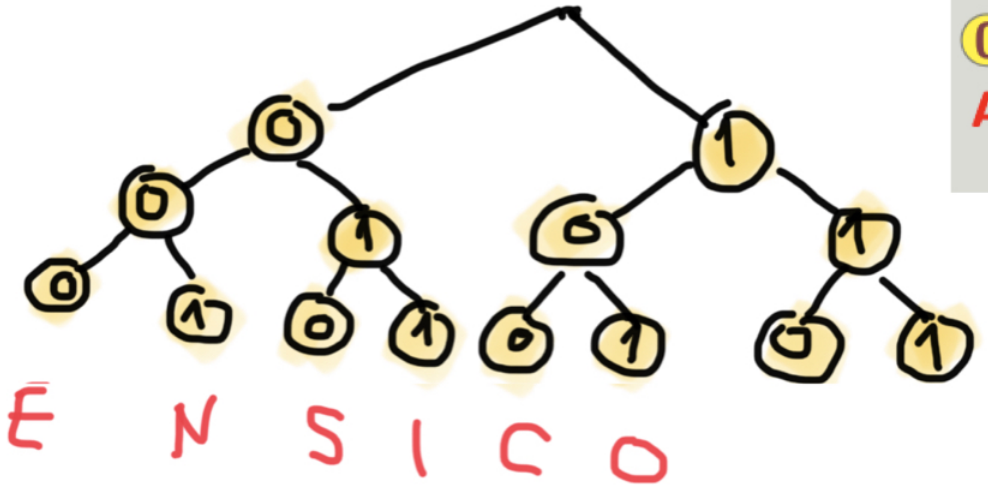


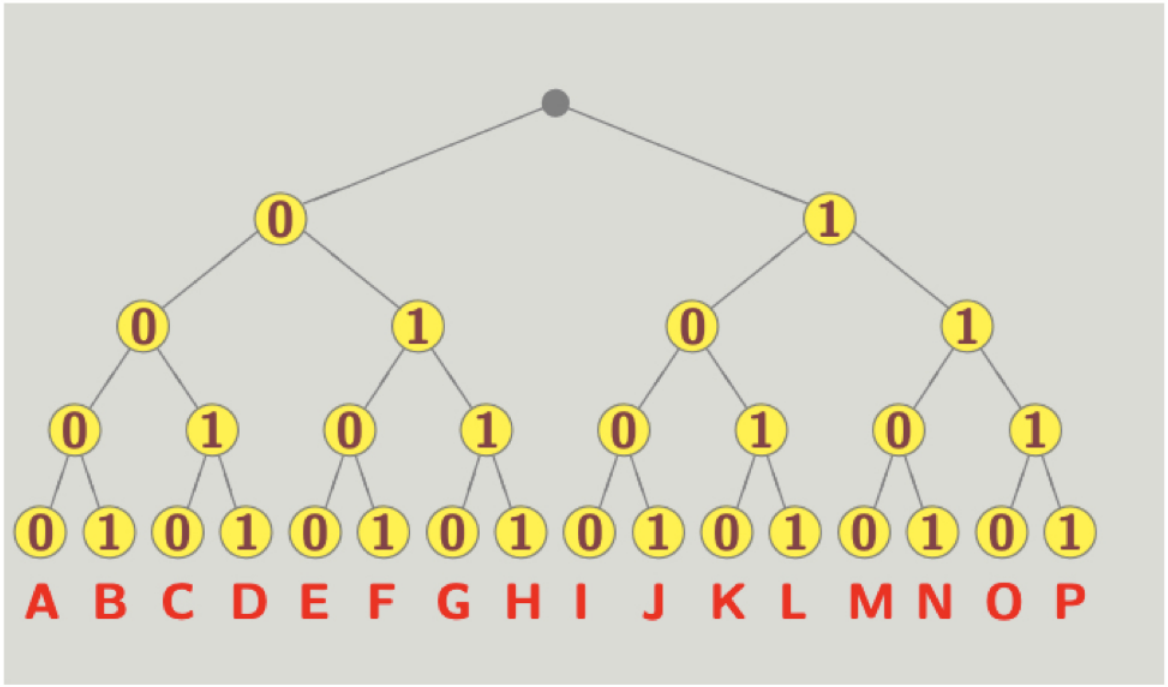







E N S I


E N S I C O


A B C D E F G H I J K L M N O P

Golden principles

Concept-first approach:

> Understanding the **concept** is way more important than mastering the **technology**.

The **What** versus the **How**

> "(...) *it is the clarity of the question, in the end, that really matters*" (Roger Scruton in The True, the Good and the Beautiful, 2017)

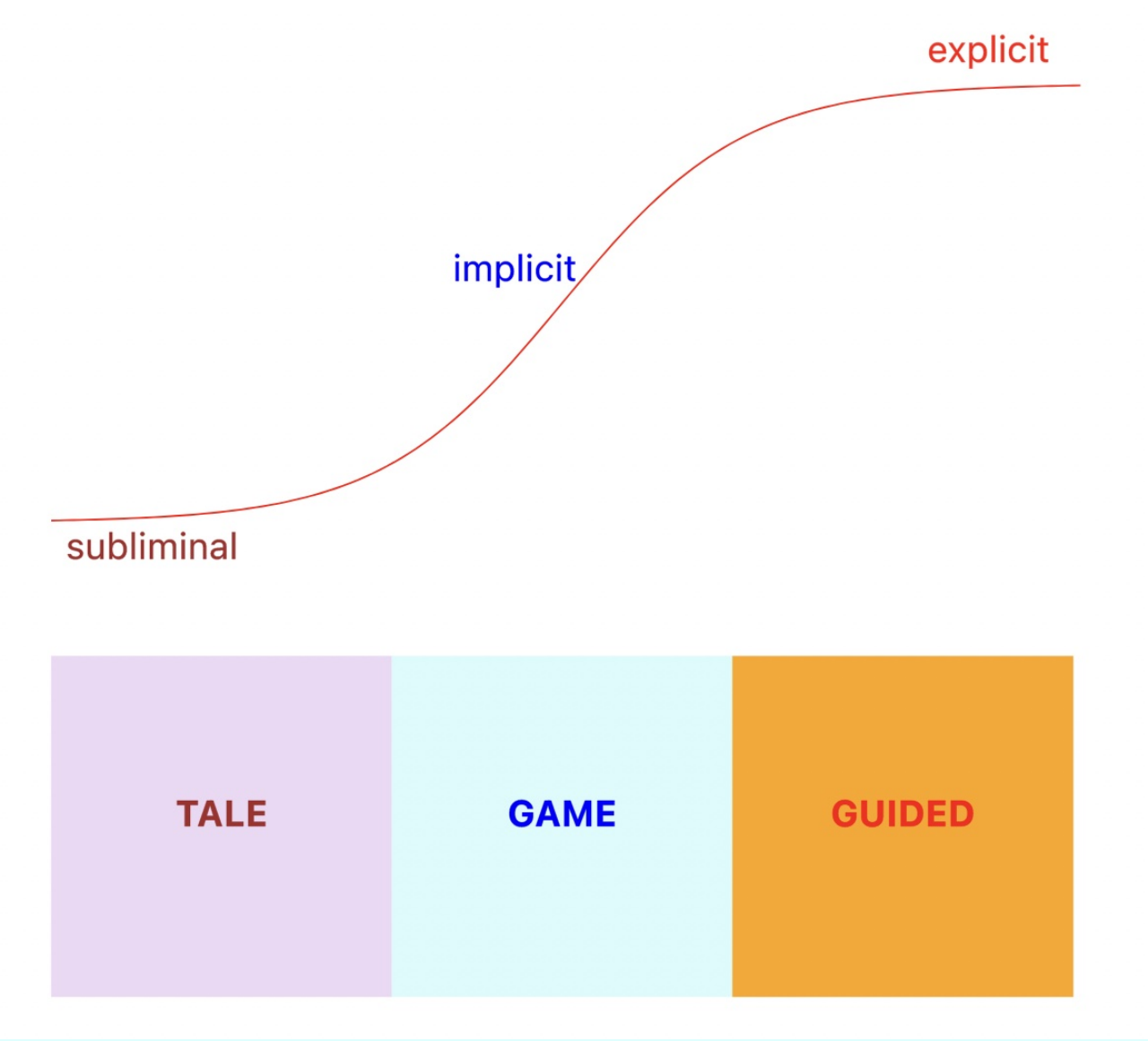
Technologies fade away, **concepts** remain.

Golden principles

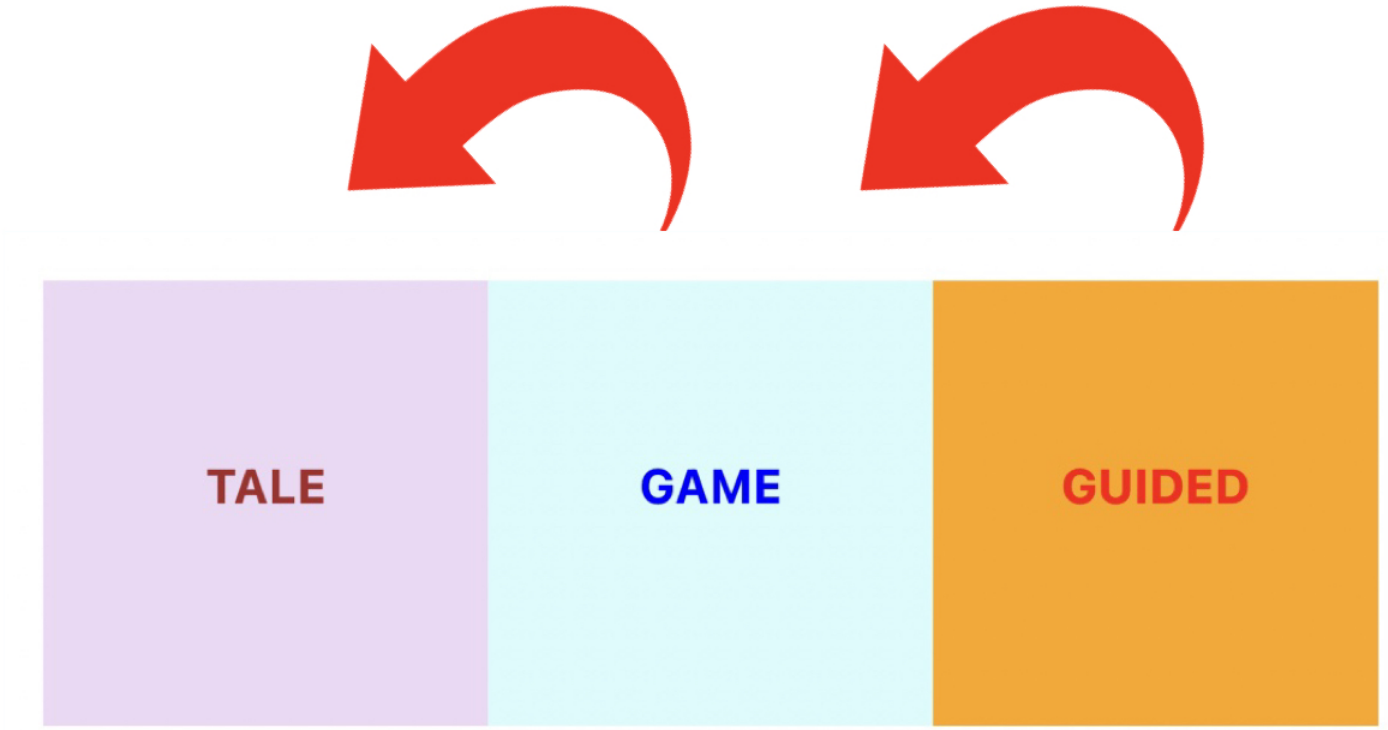
Knowledge aquisition "wave"

Teaching style modulation:

- Unplugged →
- Pseudo-plugged →
- Plugged



“Backwards teaching”



K1,K2: Once upon a time...

The adventures of Lili-no-Tongue

> She cannot speak but is able to communicate by **gestures**

K1,K2: Once upon a time...

The adventures of Lili-no-Tongue

She is helped by two fairies

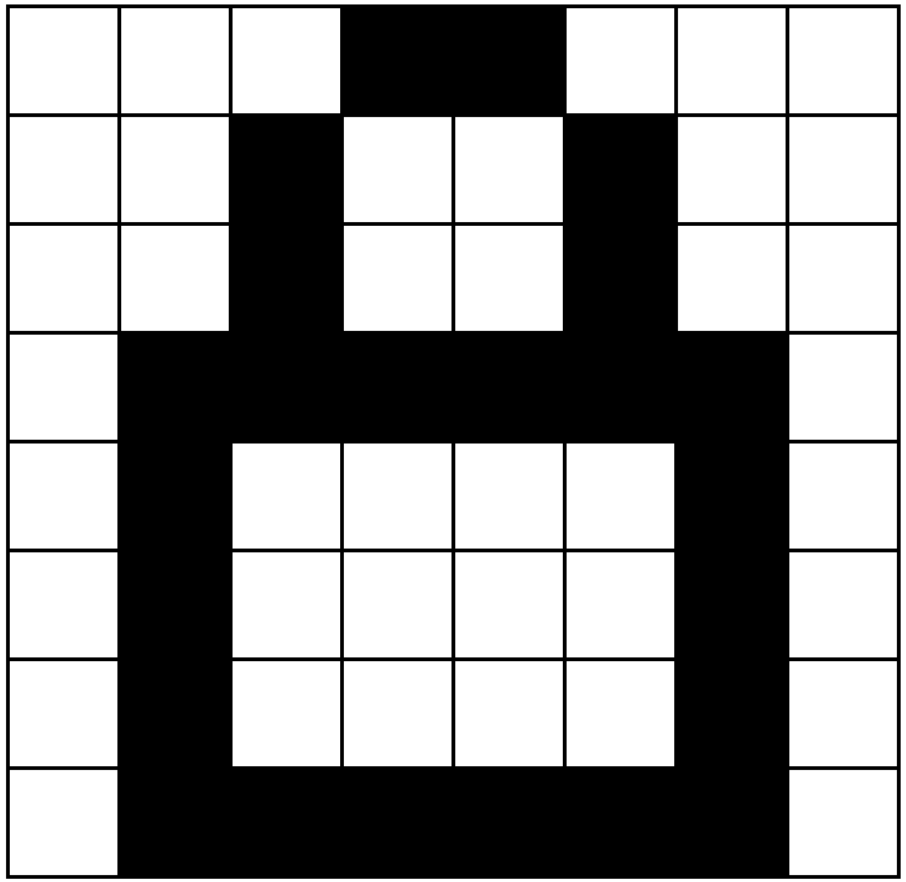
> Trocas

> Baldrocas

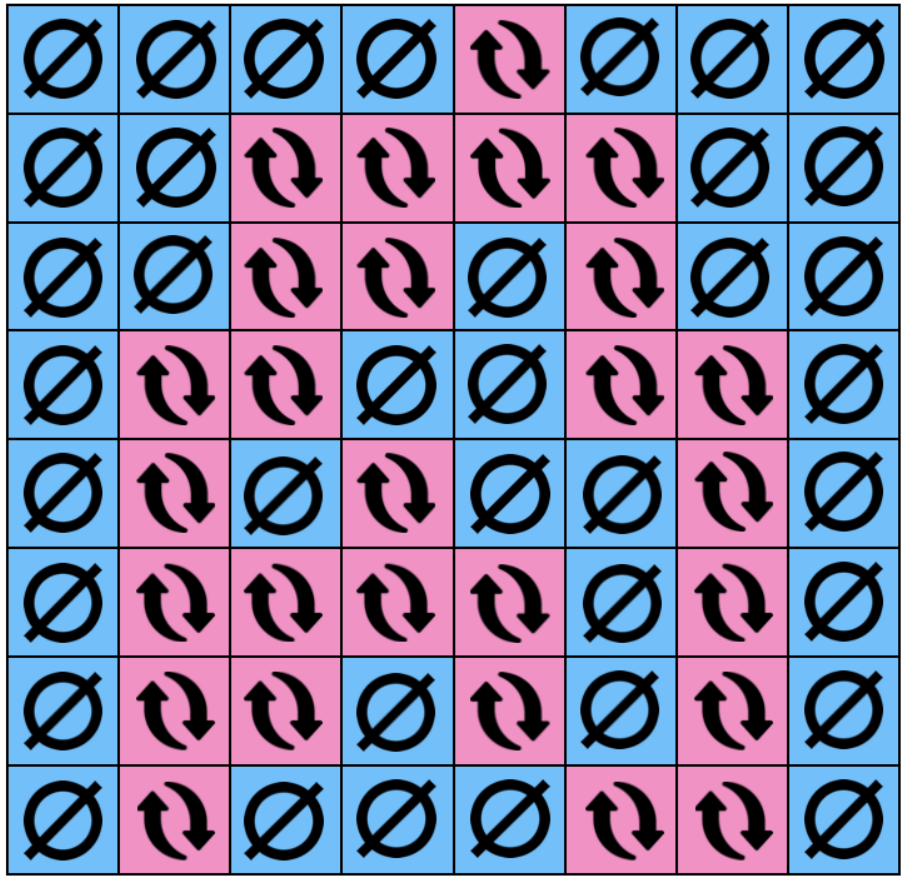
Eu sou a Trocas
E erros não cometo,
Aquilo que é branco
Transformo em preto.
Não consigo estar
Parada no banco,
Por isso o que é preto
Transformo em branco!

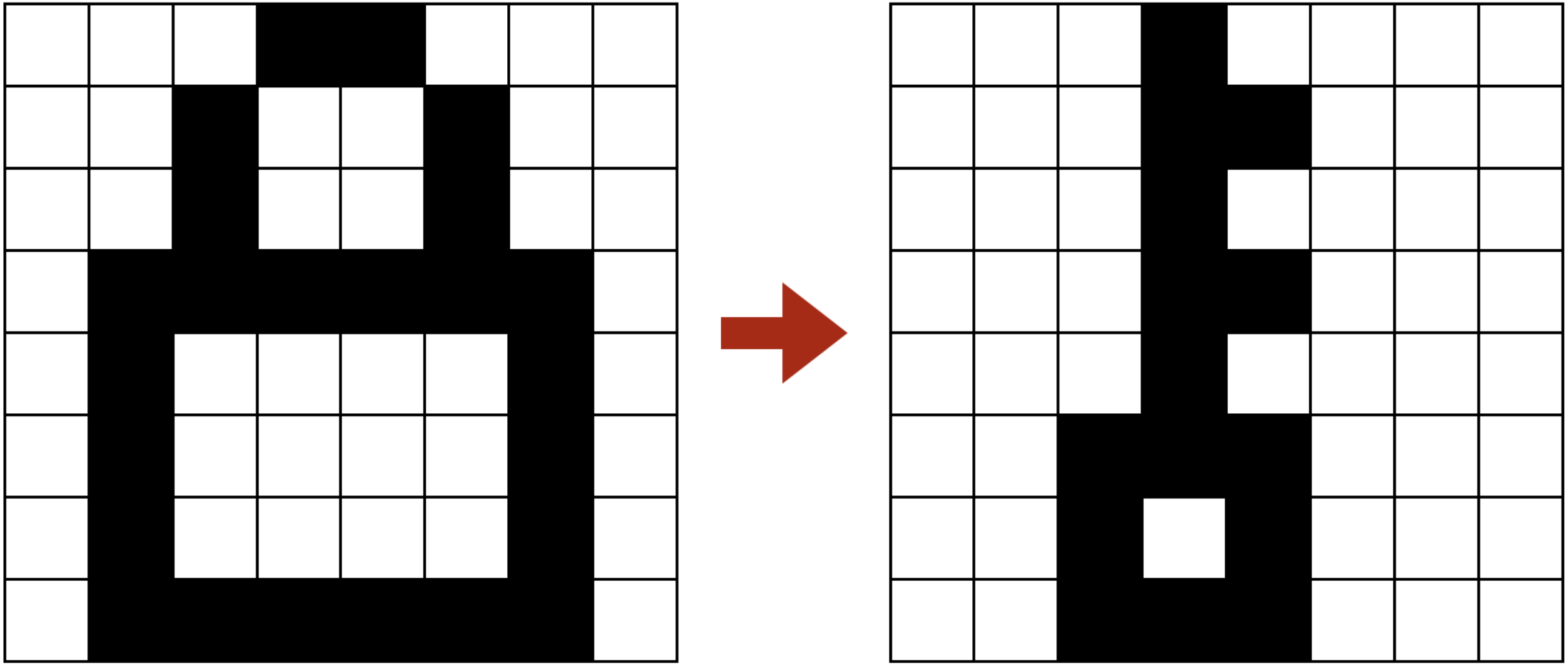
Eu sou a Baldrocas
E passo o dia sentada.
Para mim o melhor
É não fazer nada.
Nunca me mexo,
Pareço um manco,
Não mudo o preto
Nem altero o branco!

Trocas



Baldrocas





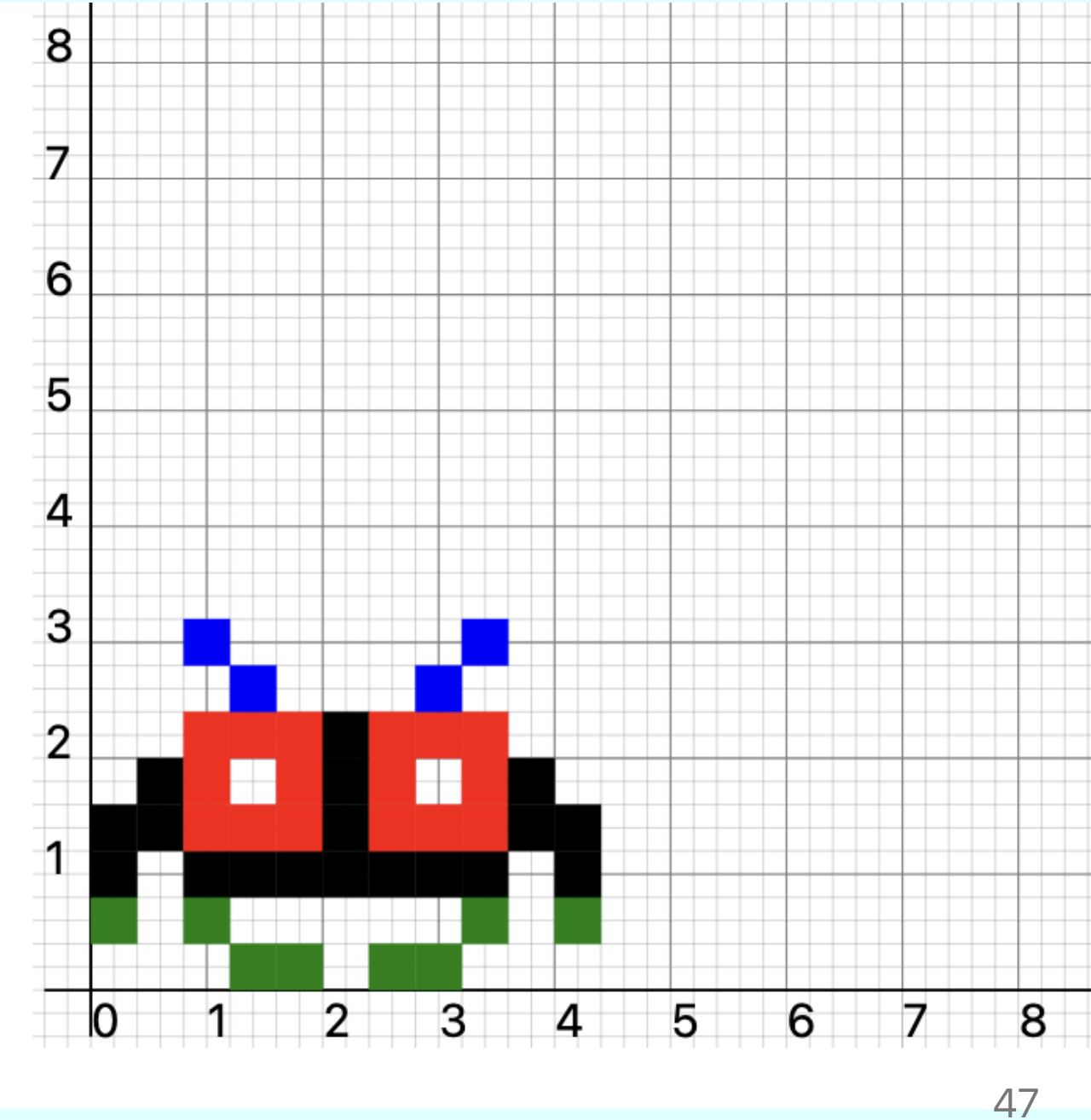
Pseudo-plugged mode

> **Tutor plugged**

> **Student unplugged**

Experience:

> Students often favor **competing** with each other in predicting the tutor's machine answer (**analysis**) against programming the machine themselves (**synthesis**).



Misconceptions

Technology marvels the **educator** more than the **student**.

Why?

> Always far behind the **computer games** and apps kids are used to in their mobile phones.

By contrast,

> Keyboard proficiency relatively low in spite of mobile phone agility.

Golden principles

Computing should **not spoil** the child's **brain** - it should rather contribute to its **development**.

Studying computing is **hard work**, not **entertainment**.

Computing is far more than **using** computers and can be done **without them**..

Debugging is not a problem solving strategy, it rather means its absence.

Data always precede the **algorithms** that manipulate them.

Plugged mode

Overall principle:

> **KISS: "Keep it Stupidly Simple" (... and cheap!)**

Thus

> Everything web-based

Choice of technology

> Jupyter Notebook

Ackn: service provided by **DIUM**.

Choice of paradigm

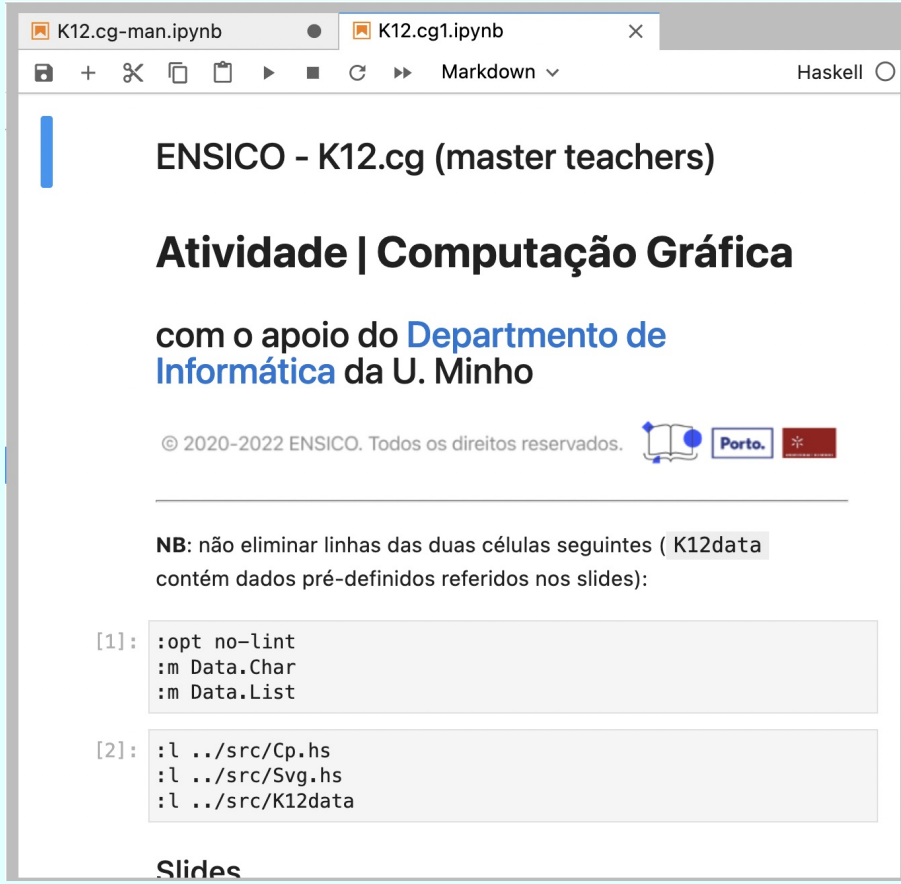
Imperative may sound more intuitive in the beginning but does not scale up.

Functional is everywhere in students maths books.

Functional is closer to **natural language** in sentence **formation** (composition) and **abbreviation**.

> the "SMS metaphor"

As in the history of Maths, the formal **H-M** language should abbreviate the informal one (**H-H**).



Língua Materna

Reparem que acima se escreveu

> *"a capital"* (*"a"*, artigo **definido**)

e não

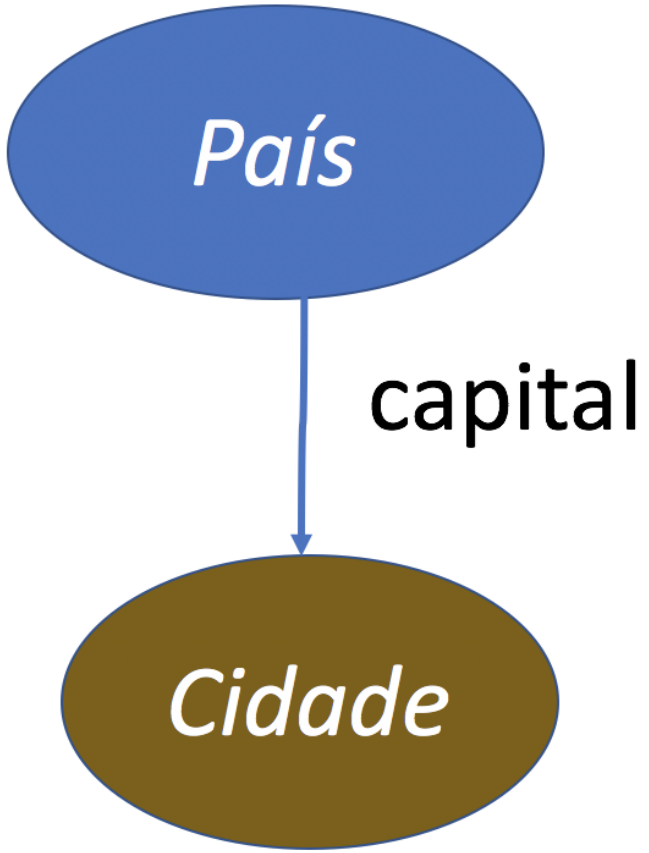
> *"uma"* capital (*"uma"*, artigo **indefinido**).

Porquê? Porque

> não só **todo** o país tem uma capital

mas também

> essa capital é **única**.



Língua Materna

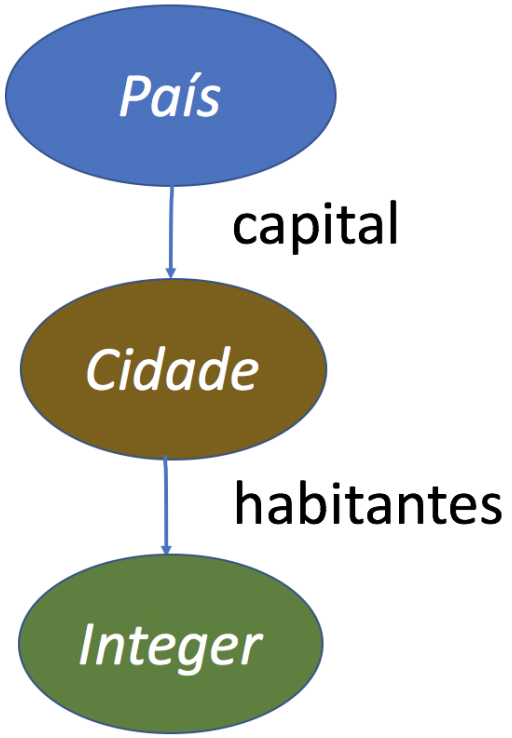
Na dia-a-dia não afirmamos factos atómicos, apenas.

Pelo contrário, estamos habituados a **encadear** frases e a dizer coisas mais complexas, por exemplo:

```
O número de habitantes da capital de Portugal
```

Encadeamentos destes podem tornar-se mais explícitos se usarmos parênteses:

```
O número de habitantes da ( capital de ( Portugal ) )
```



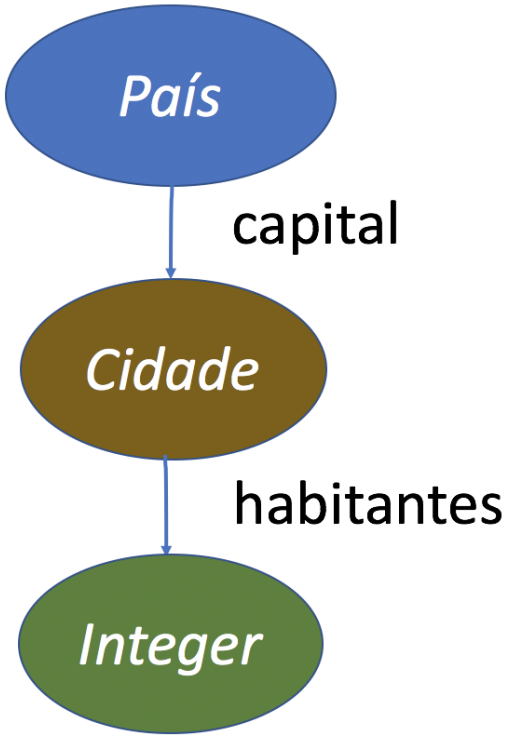
Língua Materna

Olhando para o que é importante em

> O número de **habitantes** da (**capital** de (**Portugal**))

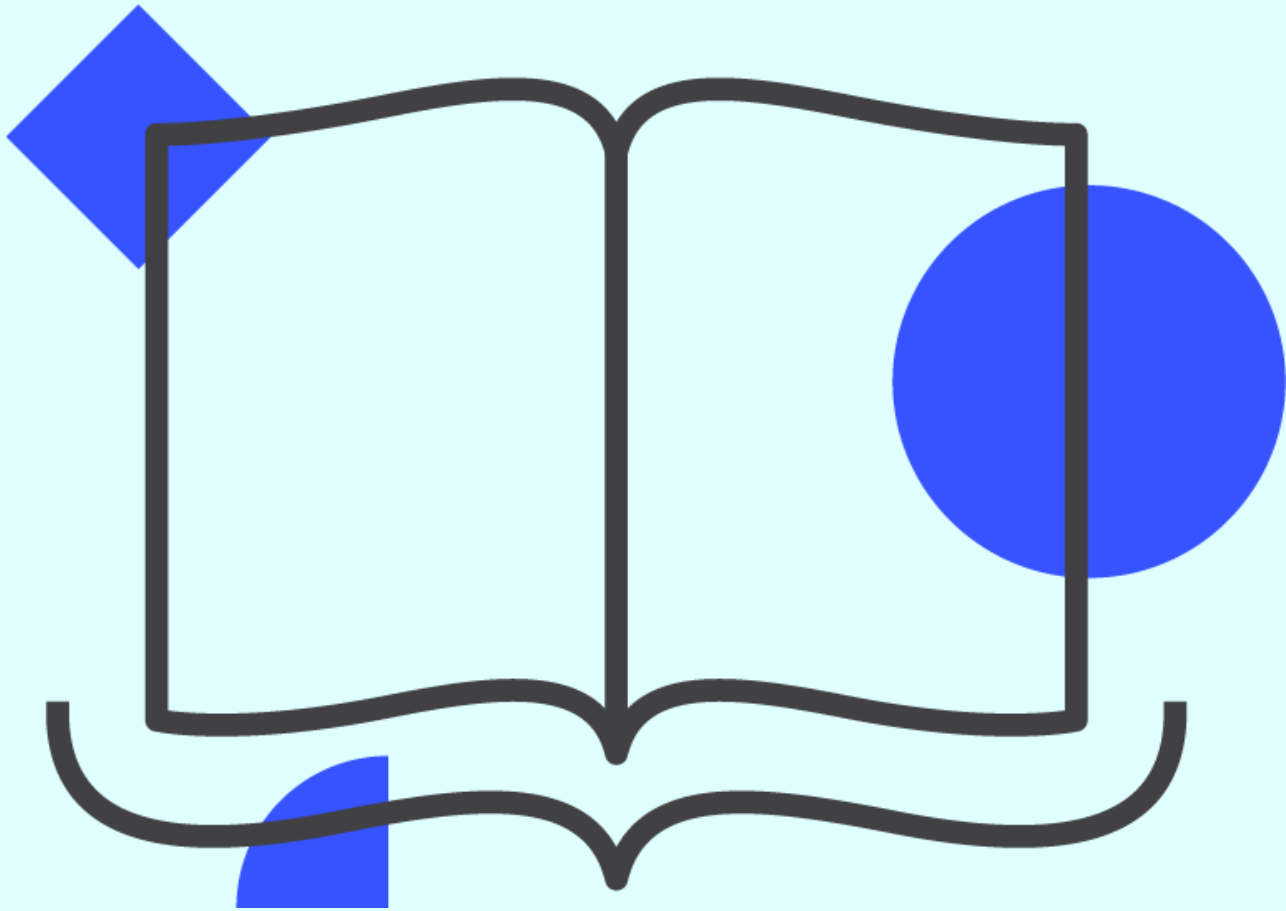
num instante percebemos como pedir essa **informação** ao computador:

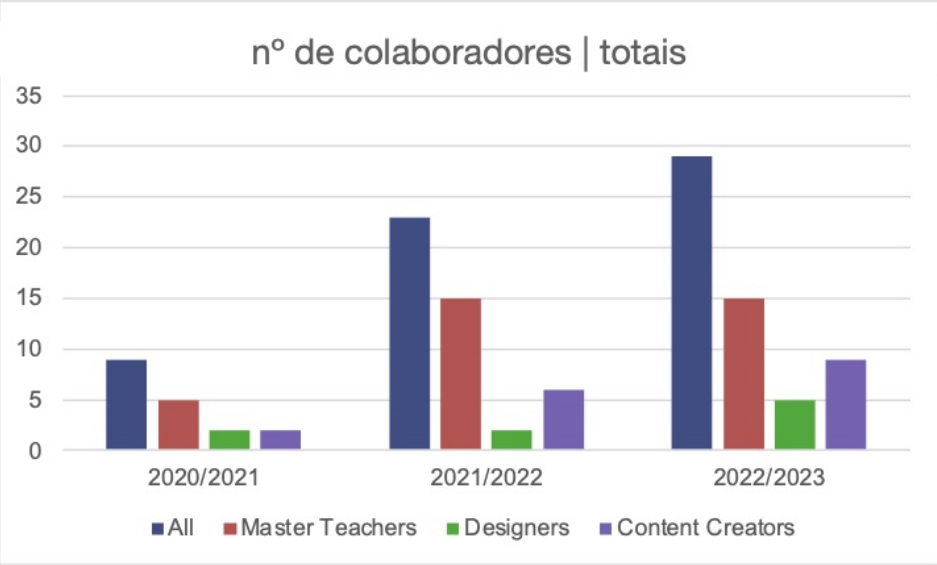
```
> habitantes(capital Portugal)
```

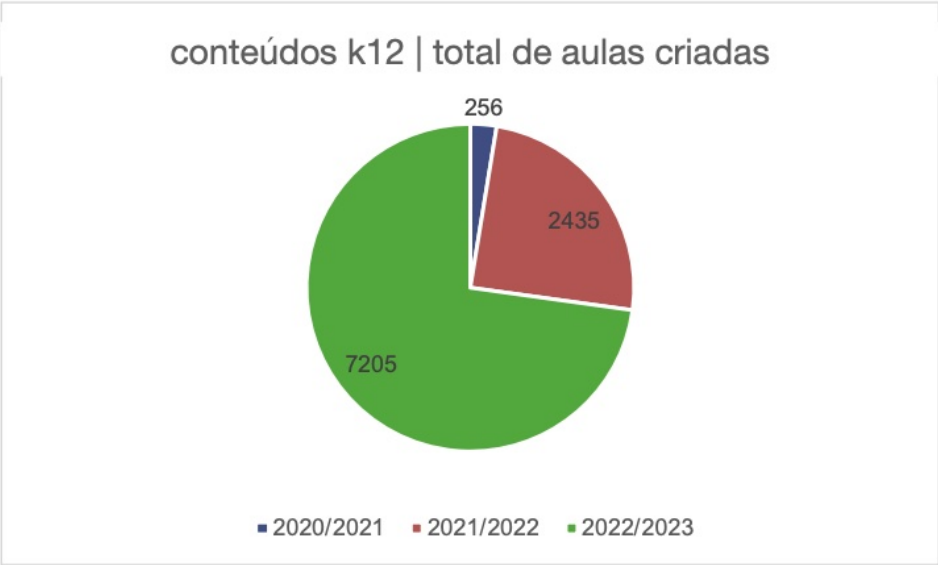


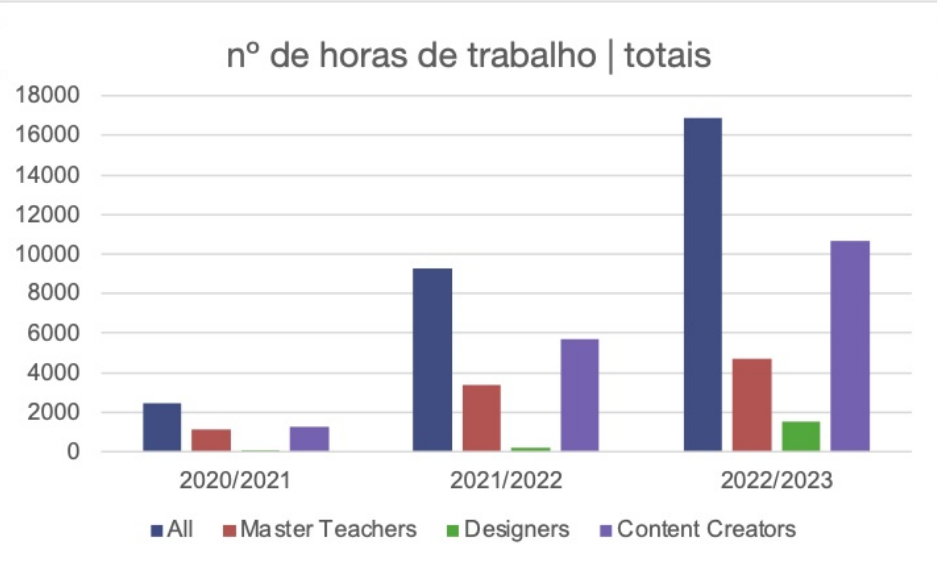
Summary

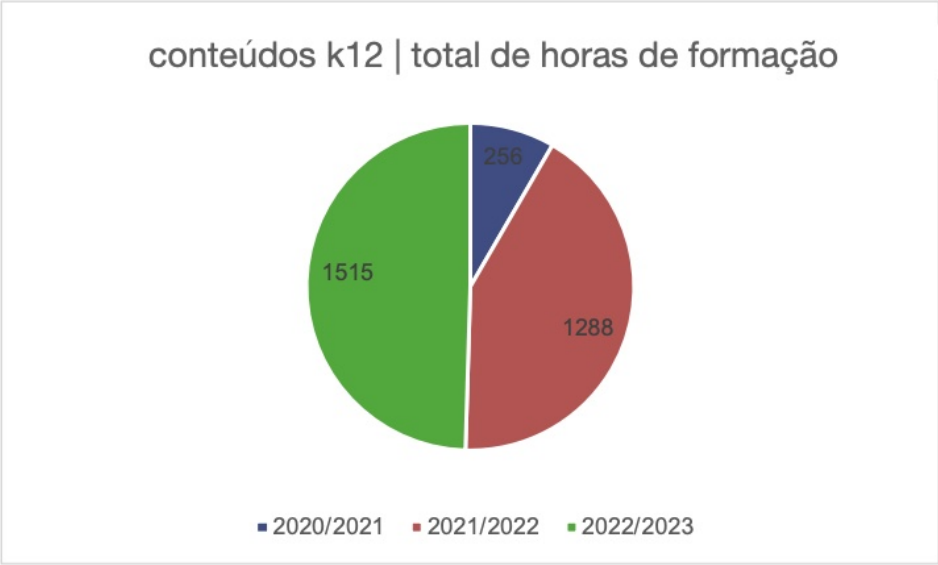
- **ENSICO**: An out-of-the-box **education project**
- Learn **by doing** and not just "by the book"
- Fighting the "**digital drug**" syndrome
- Lemma: "**Learning is fun**"




nº de colaboradores | totais
35
30
25
20
15
10
5
0
2020/2021
2021/2022
2022/2023
All
Master Teachers
Designers
Content Creators


conteúdos k12 | total de aulas criadas
256
2435
7205
2020/2021
2021/2022
2022/2023


nº de horas de trabalho | totais
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2020/2021
2021/2022
2022/2023
All
Master Teachers
Designers
Content Creators


conteúdos k12 | total de horas de formação
256
1515
1288
2020/2021
2021/2022
2022/2023

Work ahead

The "**Cascais-bang!**"

> ENSICO in **all** schools in town

Dramatic scale-up ahead

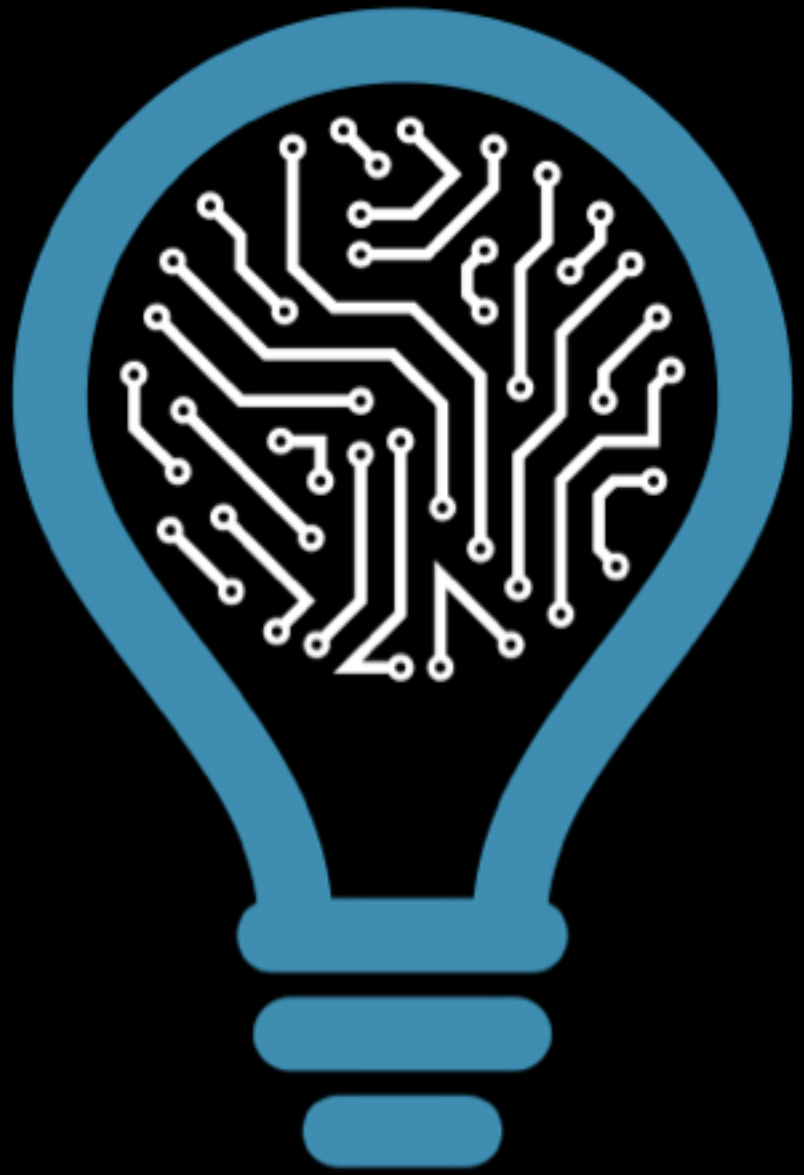
Teaching-the-Master-teacher × 10

Aulas	# alunos	# turmas	# anos de escolaridade	# escolas / colégios
2020/2021	172	8	4	4
2021/2022	850	38	7	7
2022/2023	2000	98	8	20
Aulas & Workshops	**# alunos**	**# turmas**	**# anos de escolaridade**	**# escolas / colégios**
2020/2021	172	8	4	4
2021/2022	1600	62	7	21
2022/2023	2500	130	8	28

Internationalization

- **ERASMUS** follow up
- **CAS UK**
  - ENSICO's inspiration, to be strengthened
- **UNESCO**
  - The ENSICO "computing education solution" is **not** technology-intensive and, as such, is **cheap** 😄.

from knowledge production to science-based innovation



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