From Stories to Concurrency: How Children Can Play with Formal Methods

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Citation from a Review

From one of the reviews of yesterday's paper:

> What struck me as a surprise was the authors' promotion of teaching formal methods even to school children in some form.

Computer Science and Maths

Misconception that mathematics and computer science are two independent, fully distinct disciplines

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- computer science is identified with programming and use of computers

- programming is is seen as an art rather than a science

$\Longrightarrow$ Belief that computer science does not require mathematical skills
$\Longrightarrow$ gap between computer science and mathematics

Computer Science in Schools

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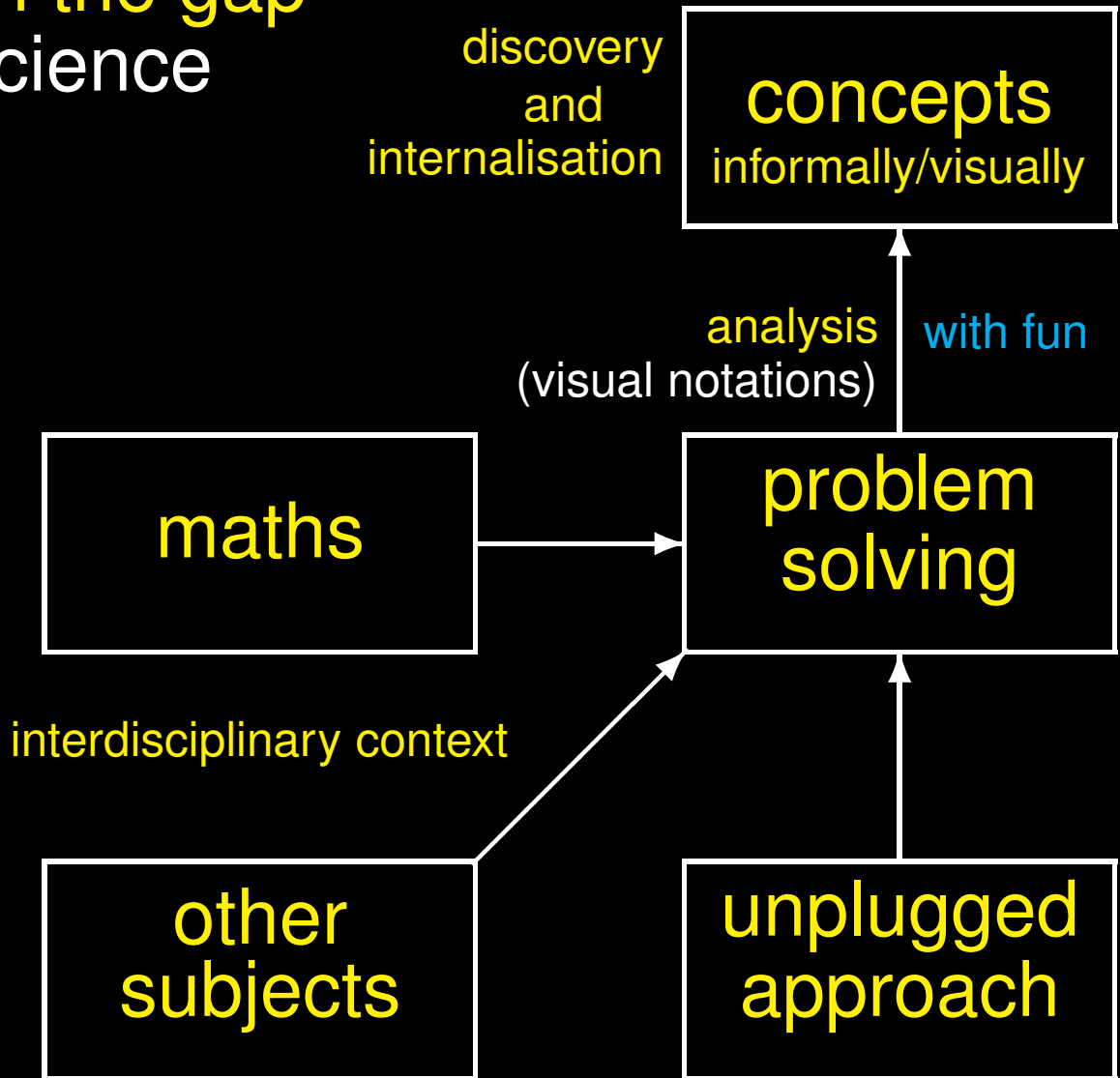- as intrinsically tied to the use of computers

Formal Methods for Children

Formal methods fill in the gap
between computer science
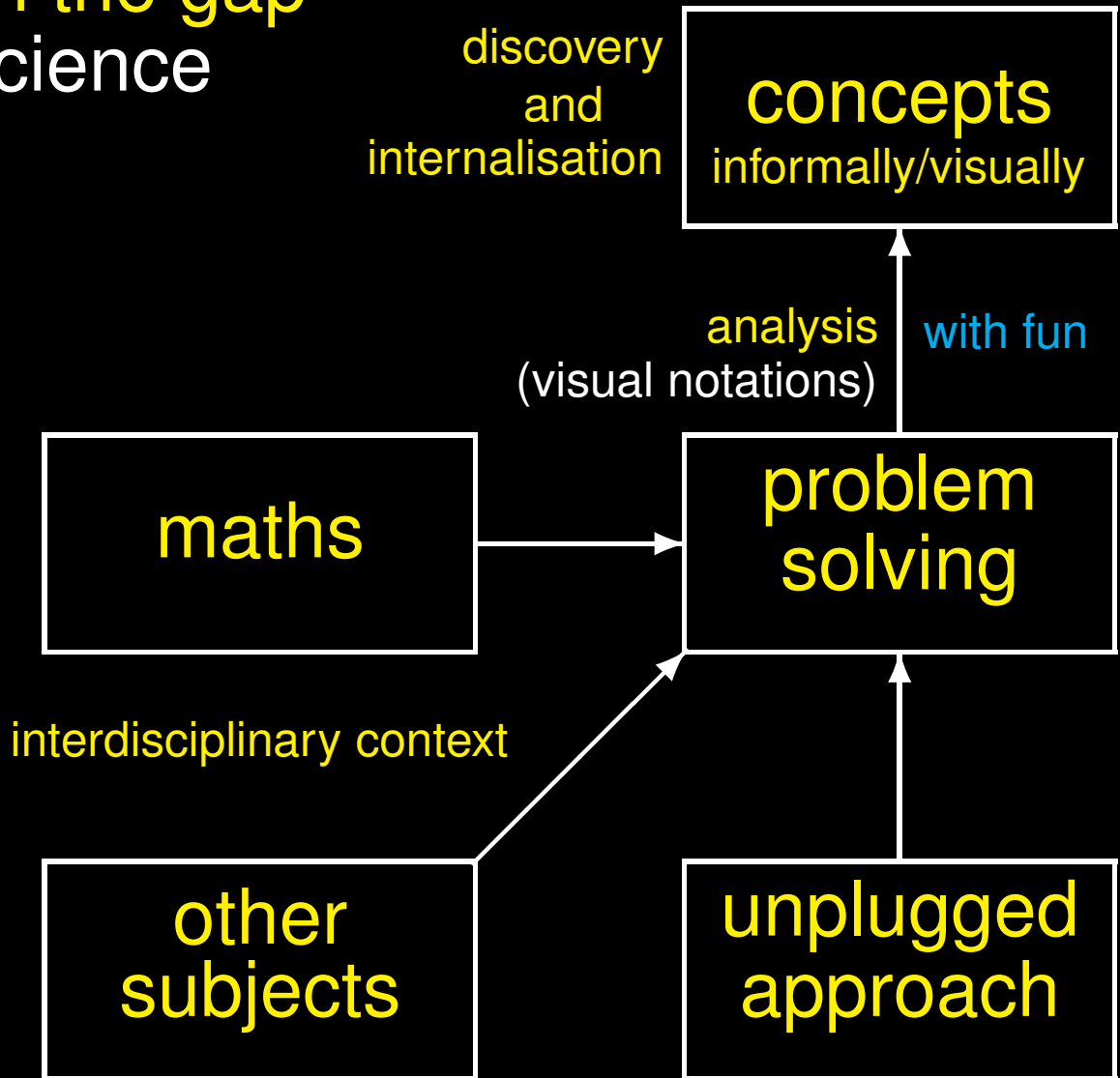and mathematics

Formal Methods for Children

Formal methods fill in the gap between computer science and mathematics

school pupils

discovery and internalisation

concepts
informally/visually

analysis
(visual notations)   with fun

maths → problem solving

interdisciplinary context

other subjects

unplugged approach

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Primary School
intrinsic motivations
(fun, challenge, competition)

Intermediate and High School
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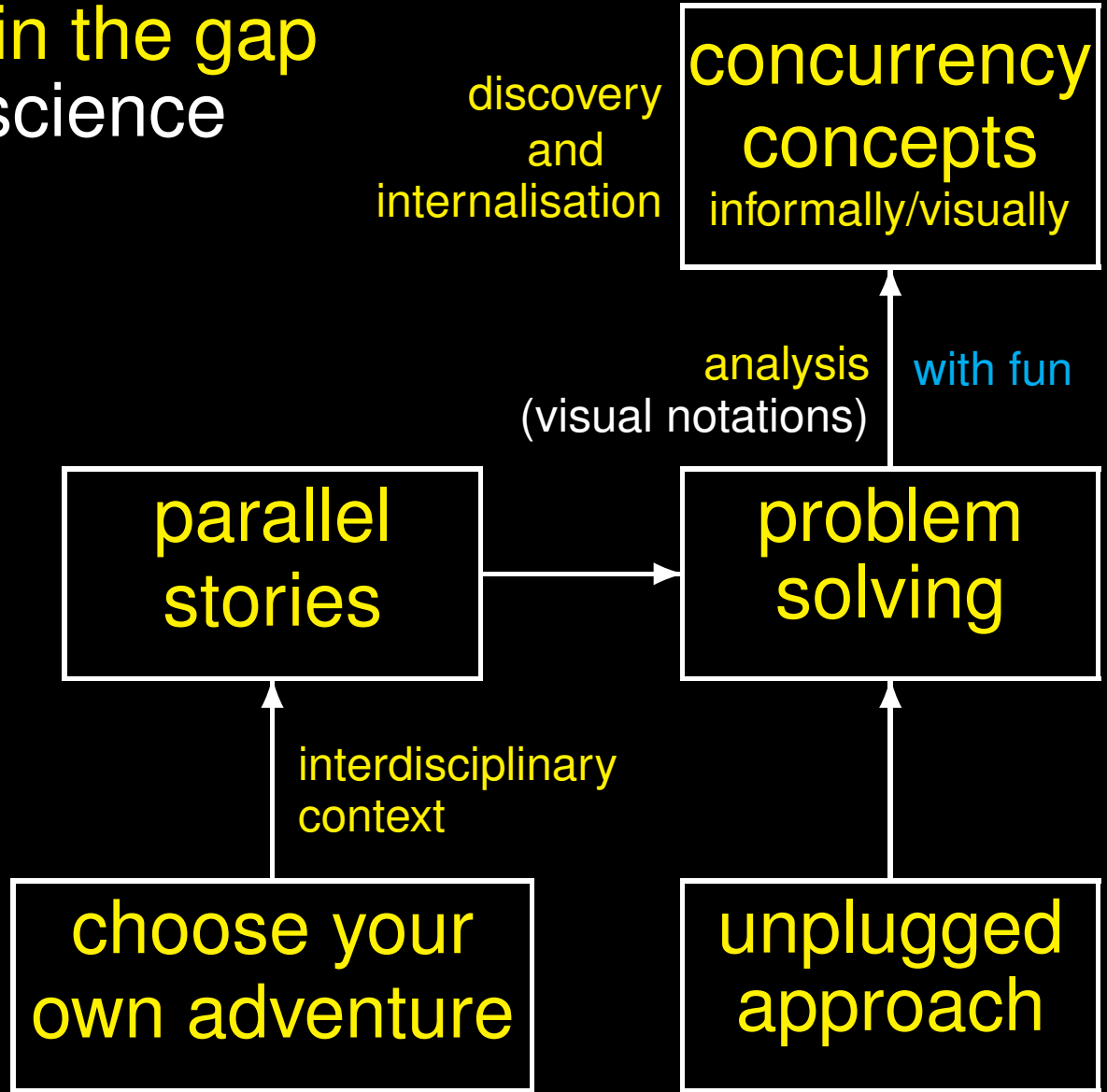
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Concept created by
Edward Packard
First book of the series in 1976

discovery
and
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parallel stories → problem solving

interdisciplinary context

choose your own adventure

unplugged approach

Why Parallel Stories?

Children are very interested in complex stories acted by many characters, who

- have their own personal stories

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Children

- can make sense of the composition of individual stories and
- understand the resultant global plot

Because . . .

Children are very interested in complex systems acted by many processes, who

- have their own behaviour

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- interact and synchronise on specific situations

- cooperate to solve problems, and

- cooperate to defeat attackers

Children

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The Story

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Question on the Story

You are looking for a treasure hidden in an abandoned castle. You enter the castle and you have in front of you a long corridor with many windows on the right side. At the end of the corridor there is a large door guarded by two parrots on their tripods. They both speak but you understand only the one on the left. The other parrot speaks a language unknown to you. The parrot on the left tells you that behind the large door there is a wide room with three small doors of different colours: the green and blue doors are not locked and you can open them and go through; the red door is locked and you do not have the key. The parrot also tells you that one of the two unlocked doors safely leads to the treasure and that if you go through the other unlocked door you will certainly die without finding the treasure.

Questions:

- Which are your possible choices?

- Which choice would you make?

- Do you know which door lead to the treasure and which to death?

The Parallel Story

Your friend is also looking for the treasure. You both start at the same time but following different paths and getting to the castle at different times. Your friend understands only the parrot on the right of the large door. The other parrot speaks a language unknown to your friend.

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Modelling Behaviour
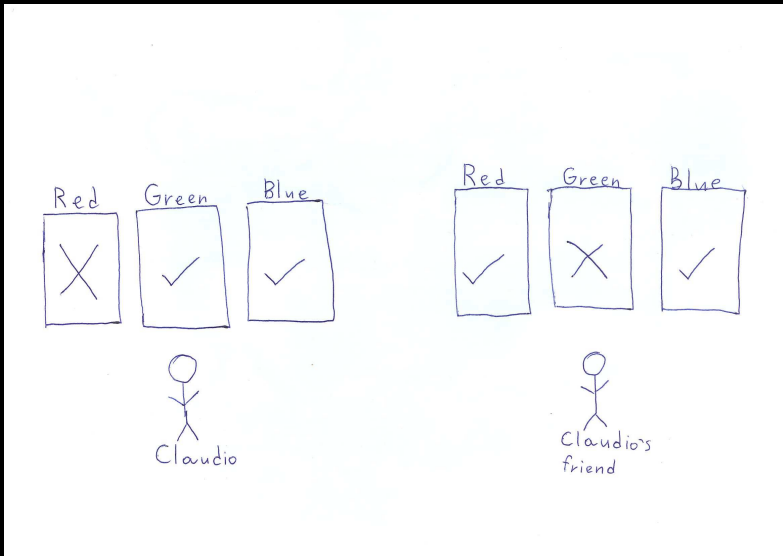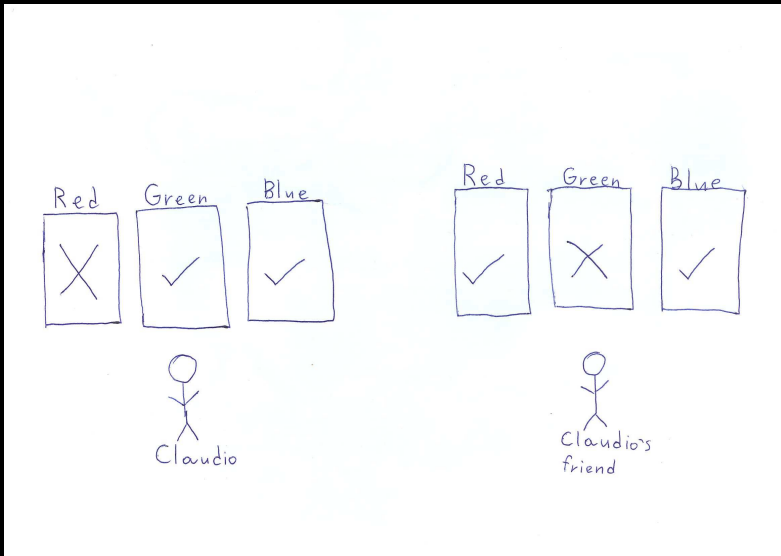

Claudio (9 year old)

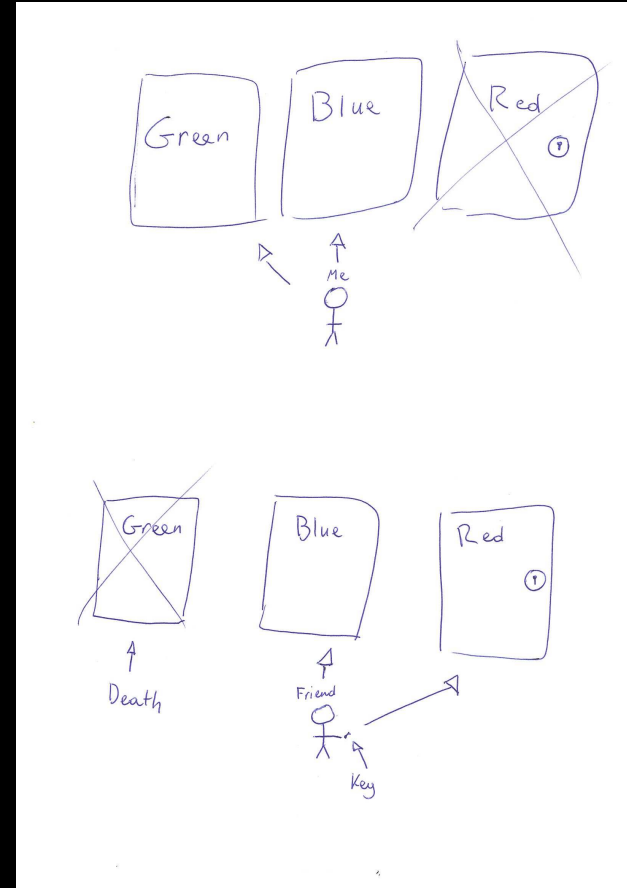# *Modelling Behaviour*
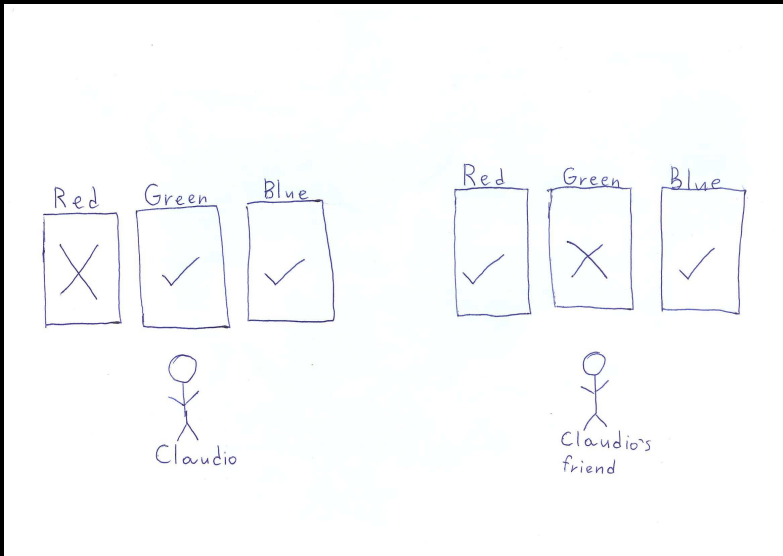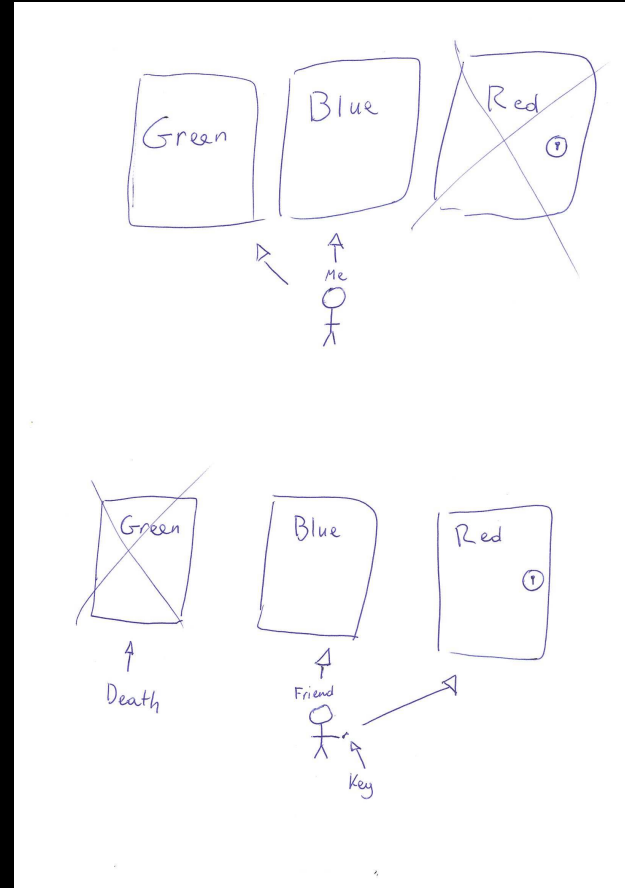
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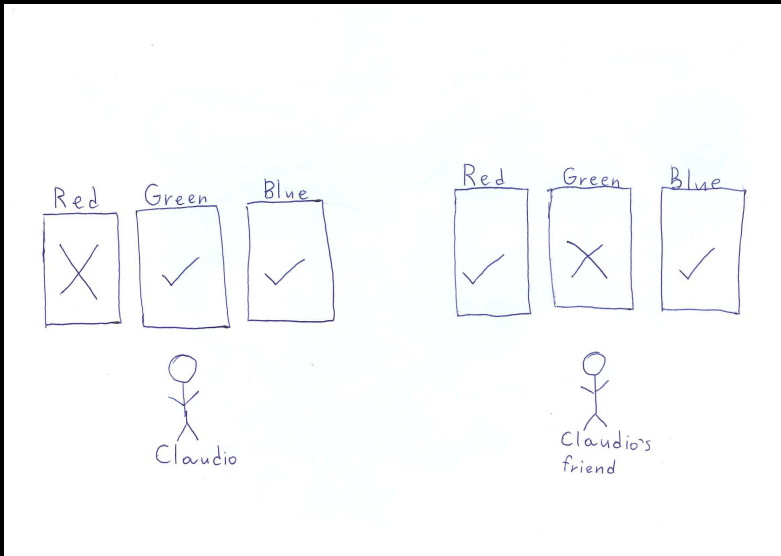

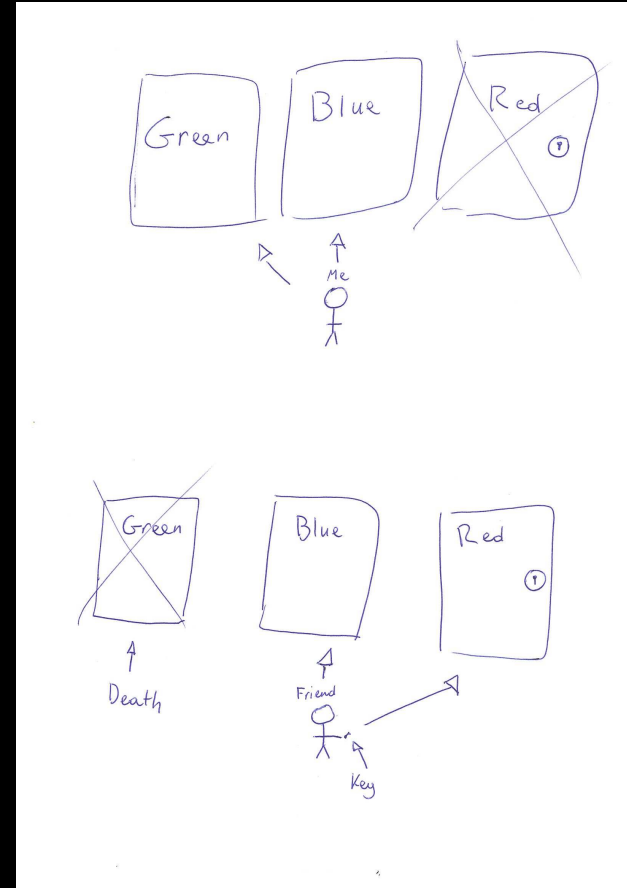Claudio (9 year old)   Chiara (13 years old)

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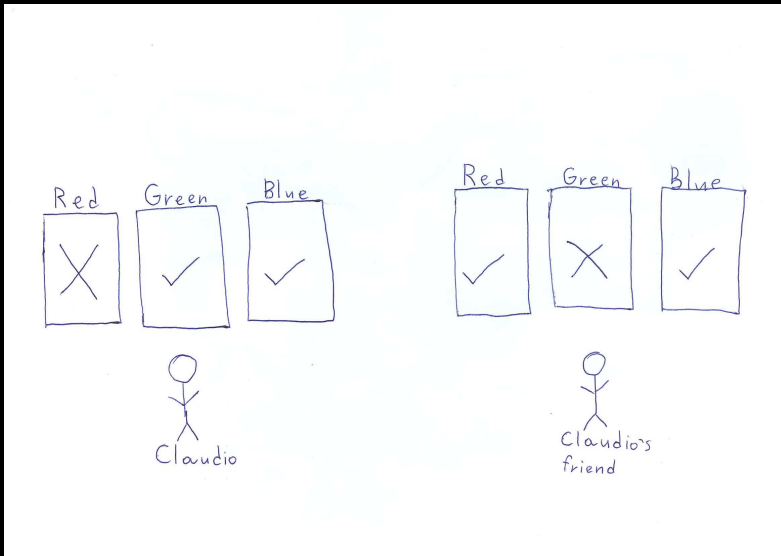
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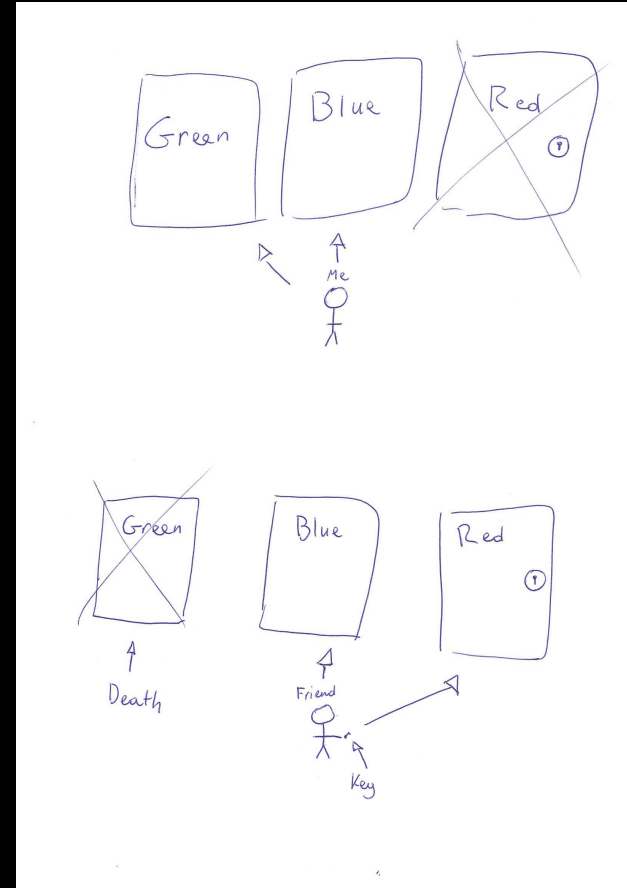

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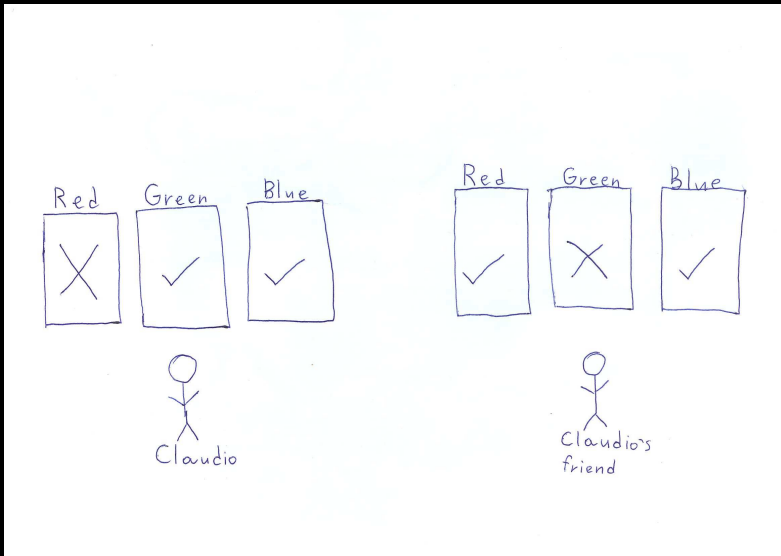Claudio also from *lock*, *key*
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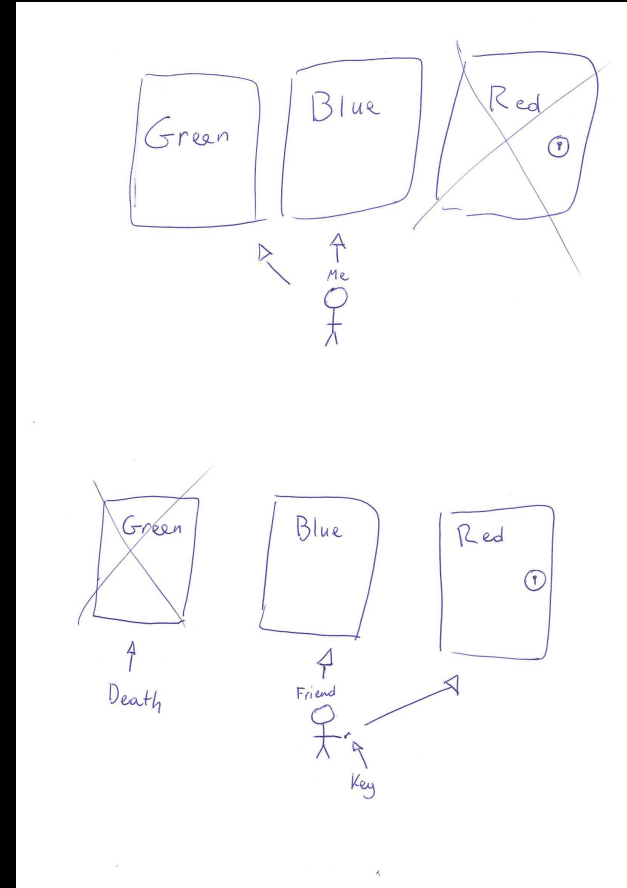
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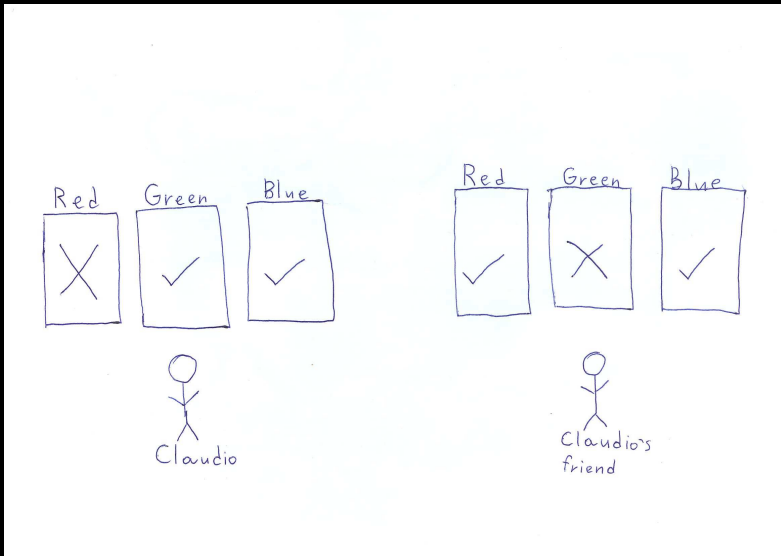and *system dynamics*

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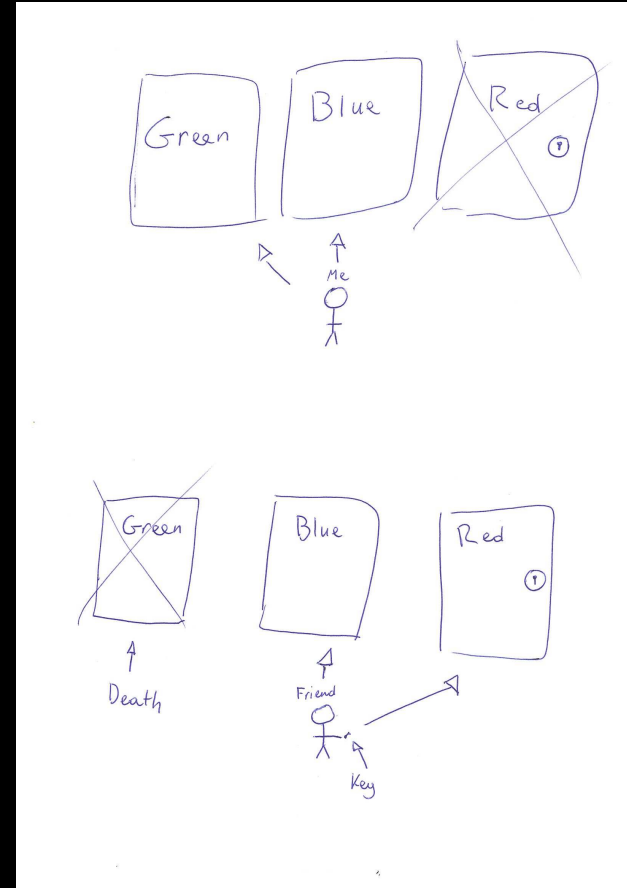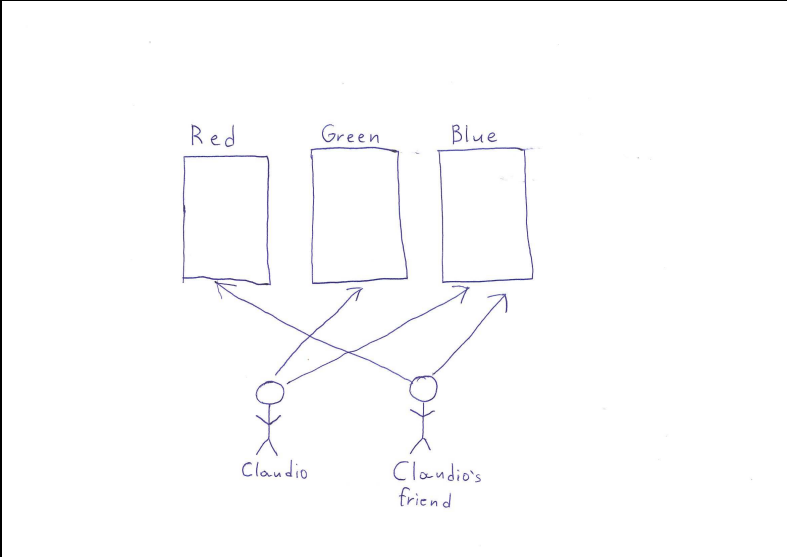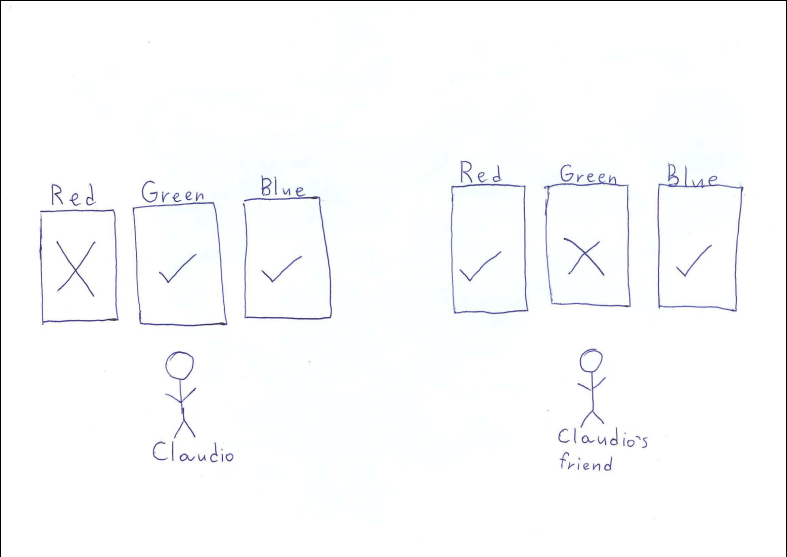
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How to compose the two parallel behaviours?

Composing Behaviours

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The parrot on the left also tells you that your friends knows

- which between the green and the blue door will certainly lead to death, and
- that what you know contains the additional information your friend needs in order to be sure to safely reach the treasure.

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  - your friend has not arrived at the castle yet and you wait for her/him but he/she may refuse to collaborate with you.
  - your friend has already gone through when you arrive at the castle
    $\Longrightarrow$ you will wait forever (starvation)

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- Uncertainty may not be due to randomness but, instead, to time issues (real-time and time-critical systems)

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Misunderstanding: we do not expect a child to appreciate these concepts, but to be exposed to them in a context with which the child is familiar with (a story) and, possibly, to internalise them.
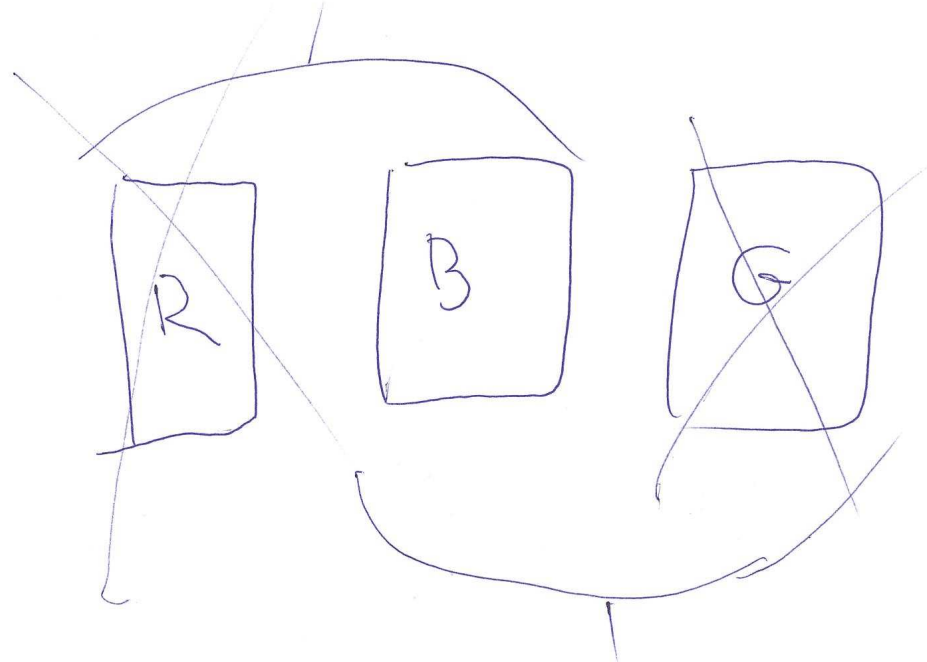
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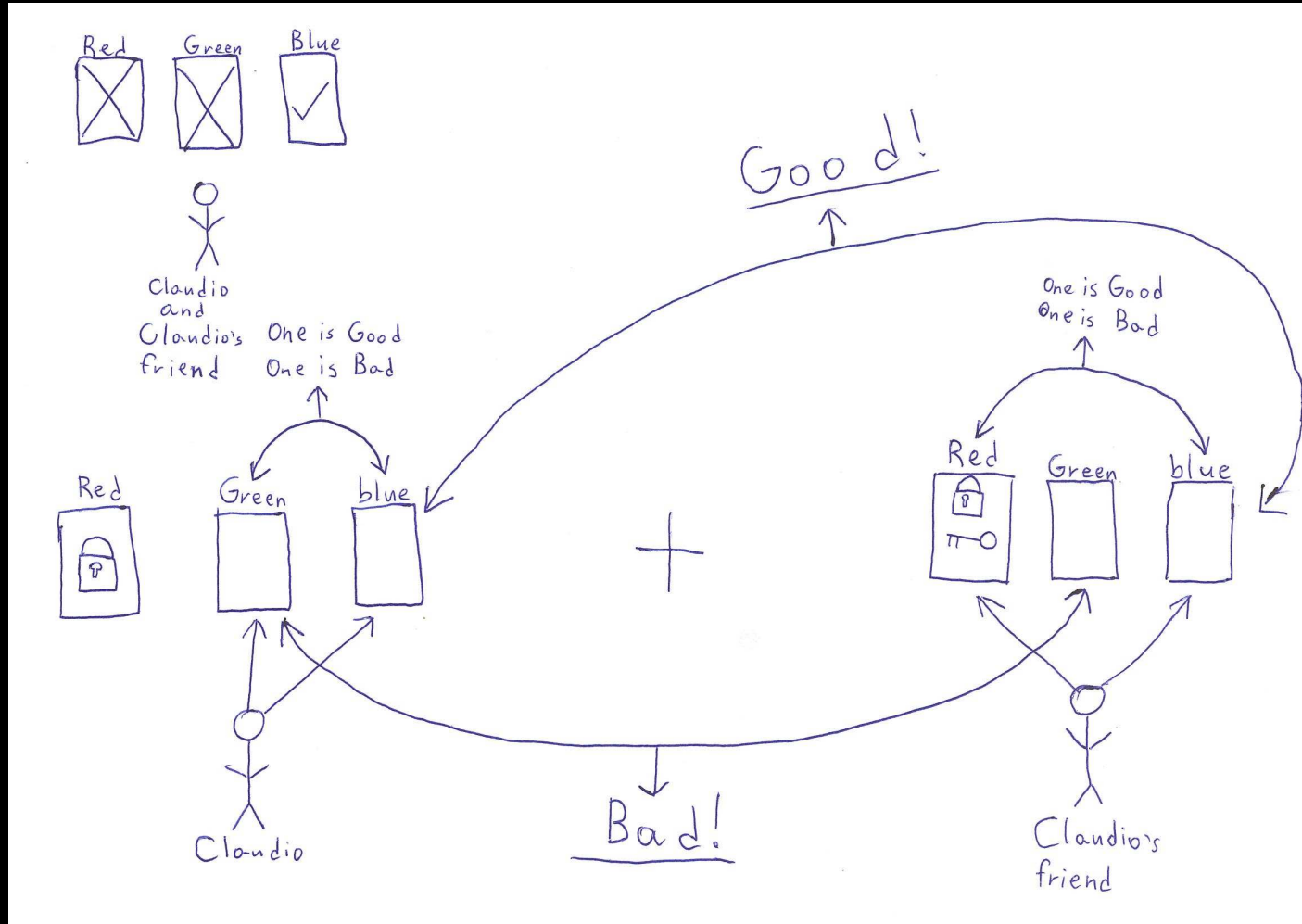
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One leads to death
the other to treasure

R   B   G

One leads to
death the other
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There's only one treasure so it's
behind the Blue door.

Reviewer's Conclusion

I have doubts whenever somebody works with his/her own children in a case study. First, because the case study is small then. Second, because there is not a neutral relationship between the children and the researcher. In this paper, the author tells that his children have been exposed to his methods for many years. This invalidates any result of the case study.

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There is no case study here.
And there are no result
This is a position paper

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- a single example of story is used to explore a large variety of concepts through the paper just for illustrative purposes.