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Applying semantic profiling to teaching Computer Science unplugged

Jane Waite and Paul Curzon
(work with Karl Maton and Jim Donohue)

We will do activities live in a Collaborative Google Doc:

http://bit.ly/LCTSept

Go there NOW and add your name (or an alias) to prove you can

teachinglondoncomputing.org/

Twitter: @cs4fn

Make sure you have paper and pencil handy… as you will be taking part

You may also want to download the teleporting robot magic trick, print it and cut it out
(or just passively watch it online)

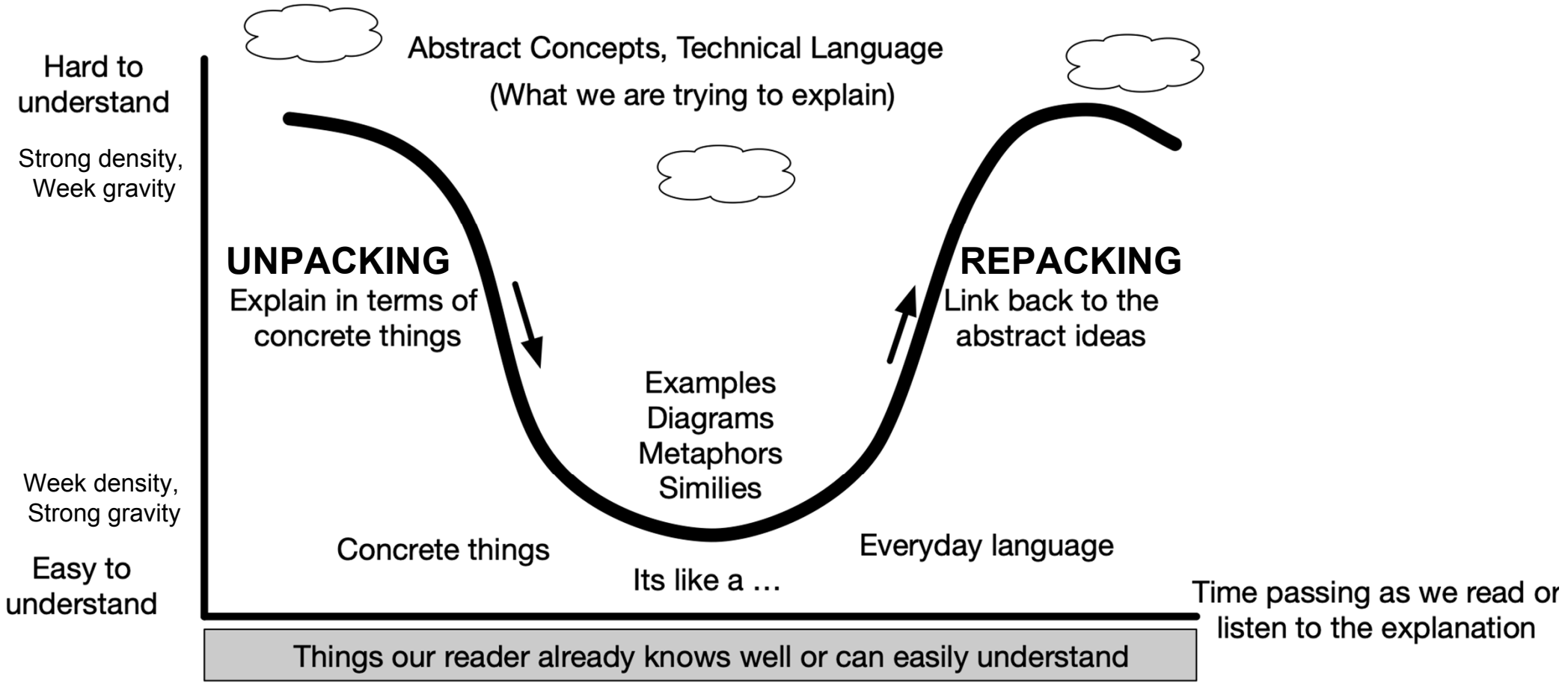
Find it in the google doc

http://bit.ly/LCTSept

Computer Science as a Case Study

- With support from Karl Maton and Jim Donohue we have been applying LCT, and particularly Semantic profiles, to our work in Computer Science
  - Teaching my students to explain
  - Analysing our own activities (see published papers with Karl)
  - Introducing Semantic Waves (based on Maton, 2013) to teachers and organisations developing teaching resources
  - Outline some simple steps that teachers can easily follow based on semantic profiling.

A good learning experience follows a wave pattern



Based on Maton 2013

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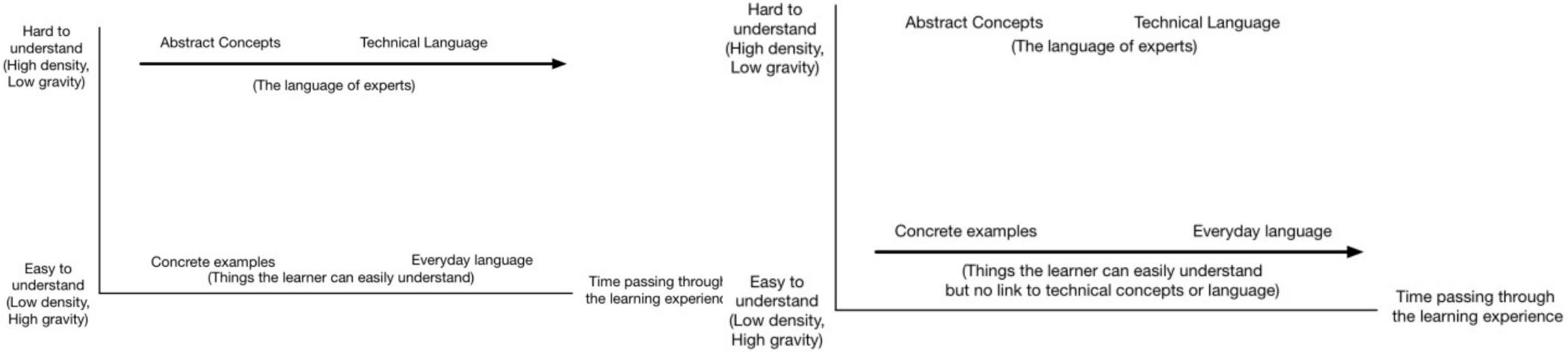
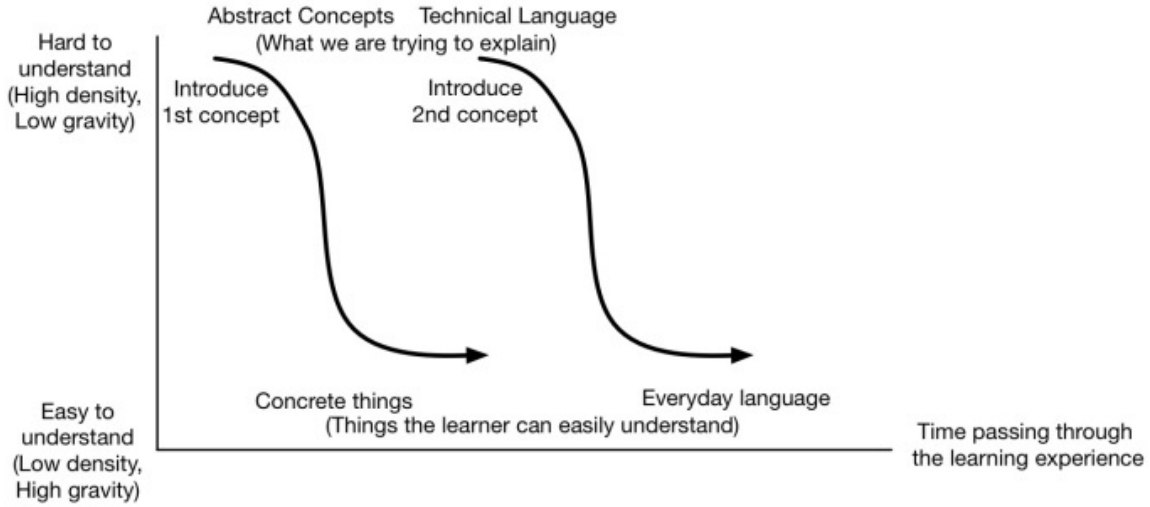
Ways to give a bad experience





Why Computer Science?

- As a discipline it is a mix of Mathematics, Science, Engineering, Linguistics and Social Sciences
- The former undergraduate subject is now being taught from primary school world wide
- There is a dearth of theoretically-underpinned pedagogy for teaching computing concepts (Waite 2017)

A language …not just a dense terminology

- Involves highly technical practical skills (eg writing programs)
- Wide-ranging, deep conceptual understanding
- VERY dense technical notation
  - not just mastering words
  - learning to read and write in complete **new languages**
  - with mathematically precise meanings (even denser maths!)
  - where what you write acts in the world

A simple program fragment

```
final int DAYS = 7;
int timesseenorangutan = 0;
printAnimalSeenInstructions();
int day=1;
while(day<=DAYS)
    {
      String message1 = "There are “;
      String message2 = "s in the wild. They are “;
      String message3 = ".";
      String animal = inputString("Day " + day + ": ");

      if (animal.equals("orangutan"))
      {
        print(message1 + 105000 + " " +  animal + message2 + "critically endangered" + message3);
        timesseenorangutan = timesseenorangutan + 1;
      }
      else if (animal.equals("pygmy elephant"))
      {
        print(message1 + 1500  + " " +  animal + message2 + "endangered" + message3);
      }
…
      else
      {
        print("I don’t know anything about that animal." );
      }
      day++;
    }
…
```

Dense meaning

"The ***while*** **construct** consists of a **block** of **code** and a **condition**/**expression**. The **condition/expression** is **evaluated**, and if the **condition/expression** is ***true***, the **code** within the **block** is **executed**. This repeats until the **condition/expression** becomes **false**." -Wikipedia.

- Is this something about buildings, spies, guillotines, people being happy or unhappy, and/or lie detectors?…
- If you didn't know what a while construct was before you still won't unless you are already have mastery of everything in red.

Computation happens in the world

- Computation also happens in everyday contexts not just in computers
  - like magic shows
  - when playing games and doing puzzles
  - when manipulating physical objects in the world
- Algorithms are invisible but they have major ramifications on our lives.

Unplugged Computing

- Unplugged Computing is a popular way to teach computing teaching concepts (Sentance & Csizmadia, 2016)
- away from computers using everyday objects and ideas
  - analogies, similes, metaphors
  - role play of computation
  - games and puzzles
  - magic and mystery
  - story telling
- Making abstract, intangible ideas tangible, physical and everyday + FUN

Different Delivery Scenarios

- whole class
- explanatory lectures
- individual

Over to Jane…
Crazy Characters

A way to quickly improve lesson plans?

- Semantic Waves naturally fits unplugged computing
- How to use semantic profiling to improve both normal and unplugged activities
- Need a way that is quick and simple
  - That teachers can easily do
    - (NOT DENSE, TECHNICAL METHOD!)
- We use a simple set of questions around simple profiles.

Heuristic Semantic Profiles

- First plot a **heuristic** semantic profile from the lesson plan
  - Focus on **RELATIVE SHIFTS** between forms of knowledge expressed
- Consider the major steps in the lesson plan as points of analysis
- **IF** the step involves more
  - **concrete/tangible** and/or simpler meanings (eg in **everyday language**)
    - **THEN LOWER PROFILE**
  - **abstract** and/or complex meanings (eg **technical language**).
    - **THEN HIGHER PROFILE**

The Questions

- First plot a **heuristic** semantic profile from the lesson plan
- Then answer the questions and reflect on ways to improve plan
  - QUESTION 1: Does the profile plotted **follow a rough wave shape** (either ‘u’– or ’n’–shaped)
  - QUESTION 2: **How far up and down** does the semantic profile move?
  - QUESTION 3: **Who is doing** the packing and/or unpacking
    - the teacher or the learner (or both)?

“Auto-ethnography” Improving my activities

- Have applied this to my activities (physical and online) eg
  - Teleporting Robots
    - Explaining the idea of an algorithm
  - Box Variables
    - Explaining the semantics of variables / assignment
- Applied method to my plan for the activities, modified the plan, reflected on the delivery, modified further.

Let’s explore an example unplugged activity: Teleporting Robot

Exercise

- I'll do the activity…**You draw the semantic profile**
- On paper or tablet or equivalent.
- I will ask you to add it or a picture of it to the google doc at the end (if you can)

THE ACTIVITY
Understanding what an algorithm is

By the end

- You will be able to explain the concept of **an algorithm**

But we will use a magic trick to do this

What is an algorithm?

- A set of instructions that
  - if followed BLINDLY and PRECISELY
  - ALWAYS lead to some guaranteed outcome.

The Teleporting Robot

One moment while I switch to my real desktop…

You too can do magic …

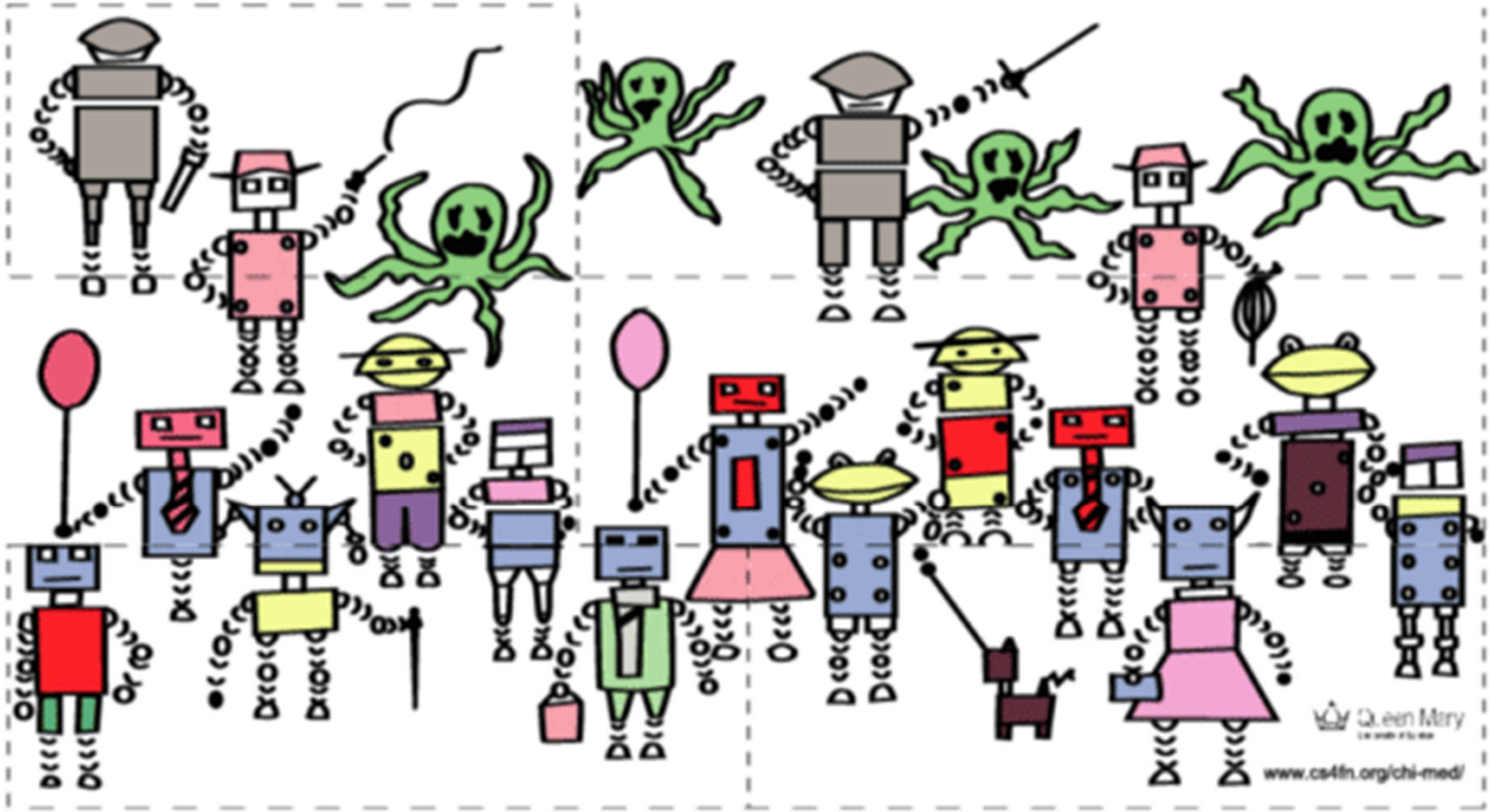
- See Activity 1 in the Google Doc http://bit.ly/LCTSept. Do the trick yourself! (OR if not I will show an online version)
- **You can do the trick, even without knowing why it works:**
  - Just carefully follow the steps.

To do the trick…

1. Build the jigsaw with the smaller pieces of the top two layers on the **left**.
2. Count the robots and remember how many there are
3. Mix up the pieces
4. Rebuild the jigsaw with the smaller pieces of the top two layers on the **right**.
5. Count the robots

A robot has disappeared

How many robots?
www.cs4fn.org/magic/



Self-working Tricks

- Magicians call a trick like this a "**self-working**" trick
- Follow the steps in the right order and the trick just works
  - Even if you have no idea what you are doing
- Computer Scientists call it an **algorithm**
  - **Precise set of steps that if followed guarantee some result.**
  - I wrote it in English for a human to follow

Programs

- I wrote the trick's "algorithm" in English for a human to follow
- When programming we write algorithms as a program in a programming language for a computer to follow
  - Computers have no idea what they are doing
  - They must have precise steps they can follow blindly
    - They can only follow algorithms written in a precise language
  - They have to always work

Exercise: Explain “algorithm”

- Go to the Google Doc and do activity 3.
- http://bit.ly/LCTSept.
- Briefly explain what is meant by an algorithm illustrating your answer with an example

What is an algorithm?

- Precise instructions of how to do some specific thing
- Must be followed exactly and in the specified order.
- If done so they guarantee to do that thing correctly.

- A computational agent should be able to blindly follow the instructions
- Without ANY understanding of what they are doing or why.
- The result should still be obtained.

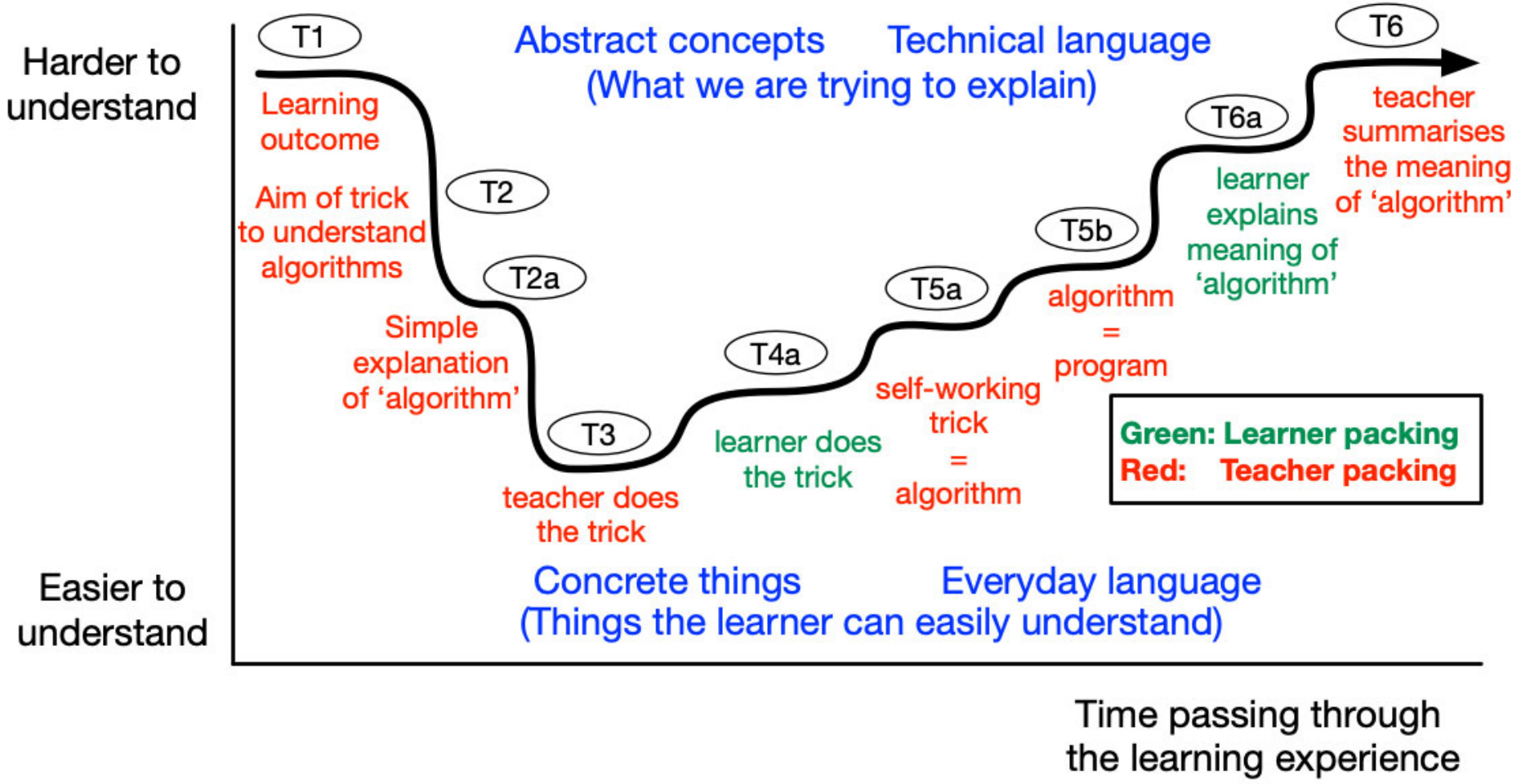
END OF ACTIVITY!!

Sketch the profile of the Teleporting Robot Activity

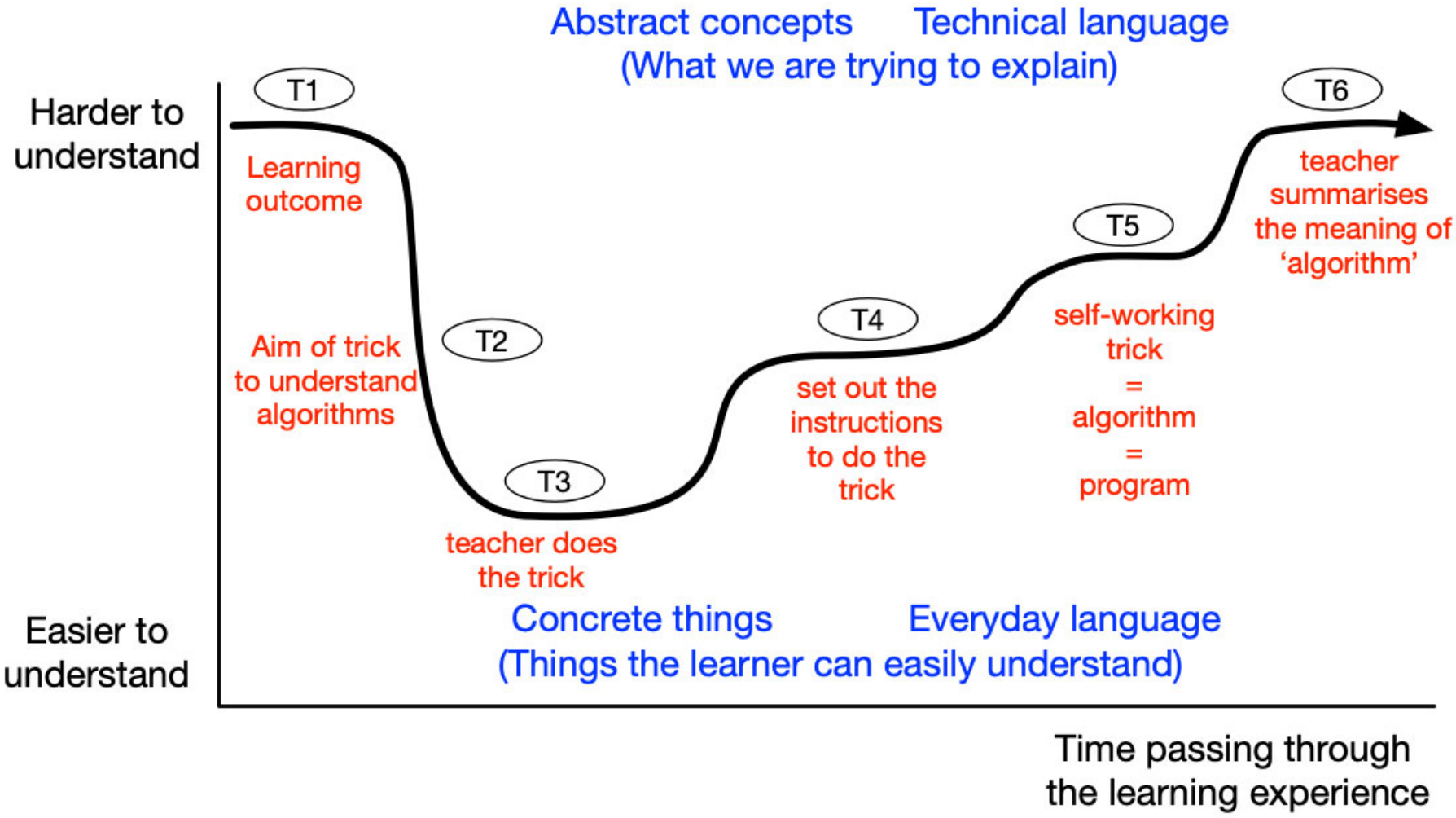
If you have a simple way to do so…
Add your sketch of the profile of the teleporting robot activity to the Google Doc
http://bit.ly/LCTSept. Activity 3

1. Introduce learning outcome…
2. explain the concept of an algorithm
3. Do the trick
4. Give you instructions / Let you do the trick
5. Explain link self working tricks…algorithms
6. Explain the link algorithms …programs
7. You summarise Algorithm
8. I summarise Algorithm

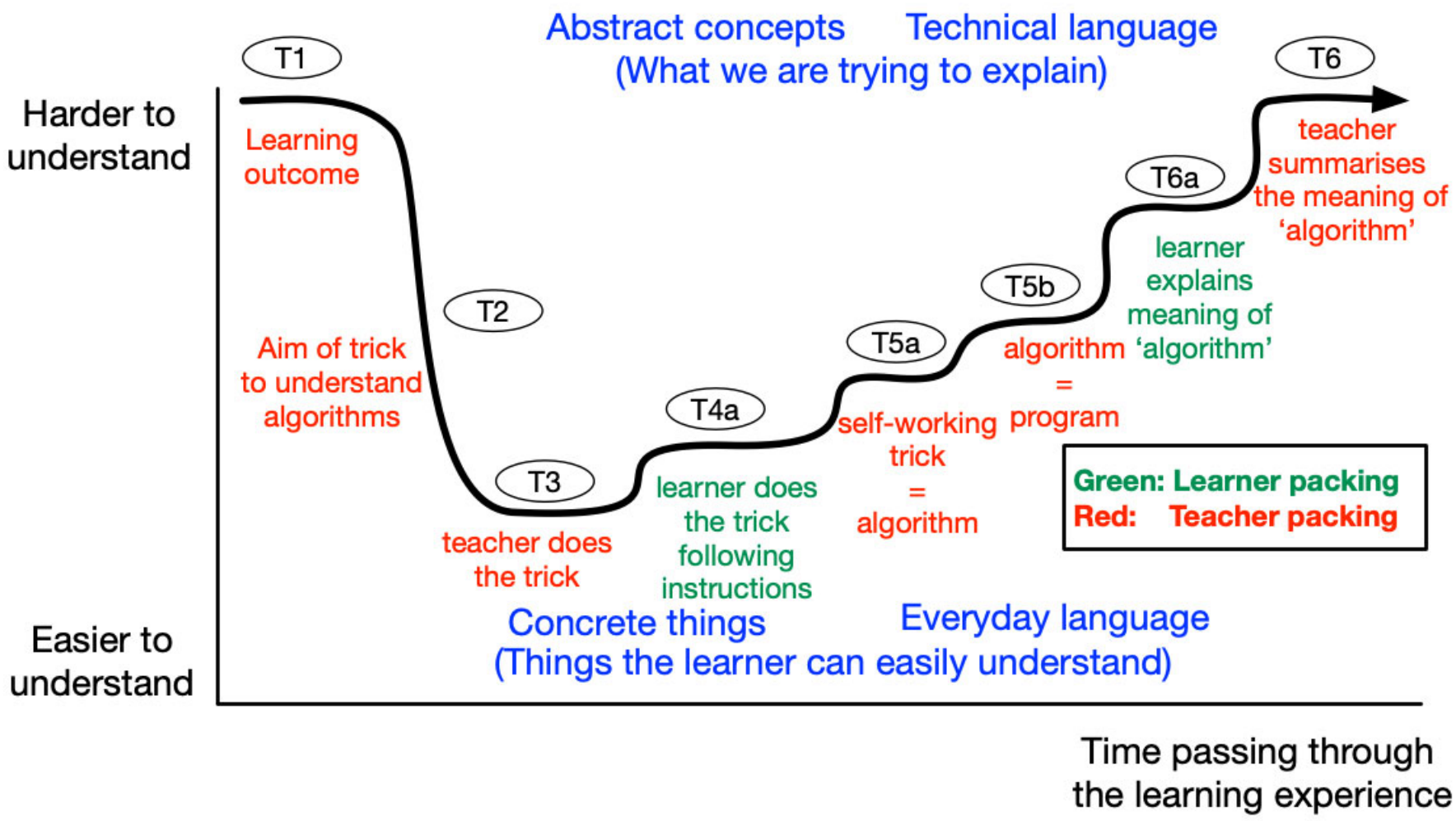
What I think I just did



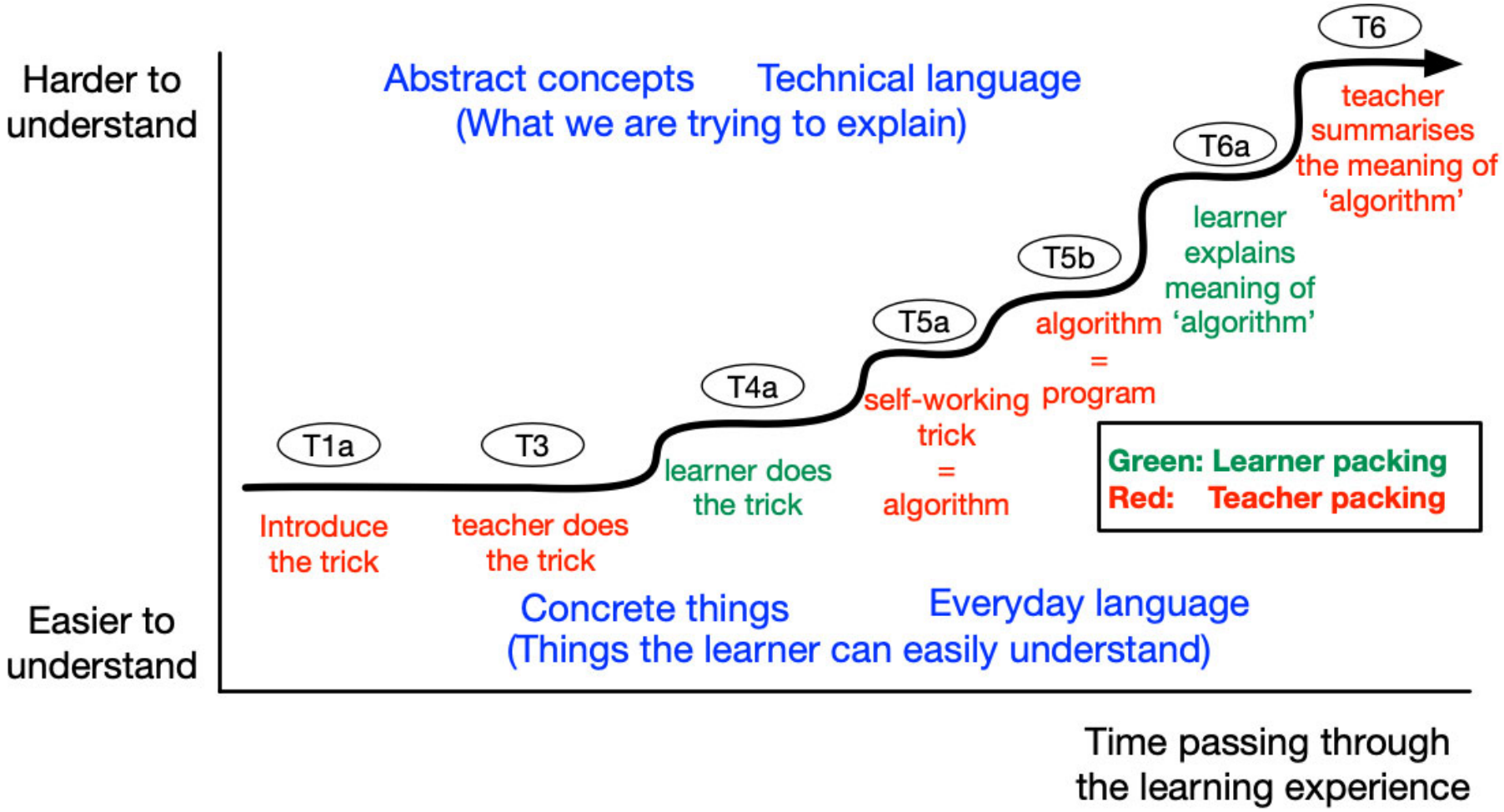
What I originally planned



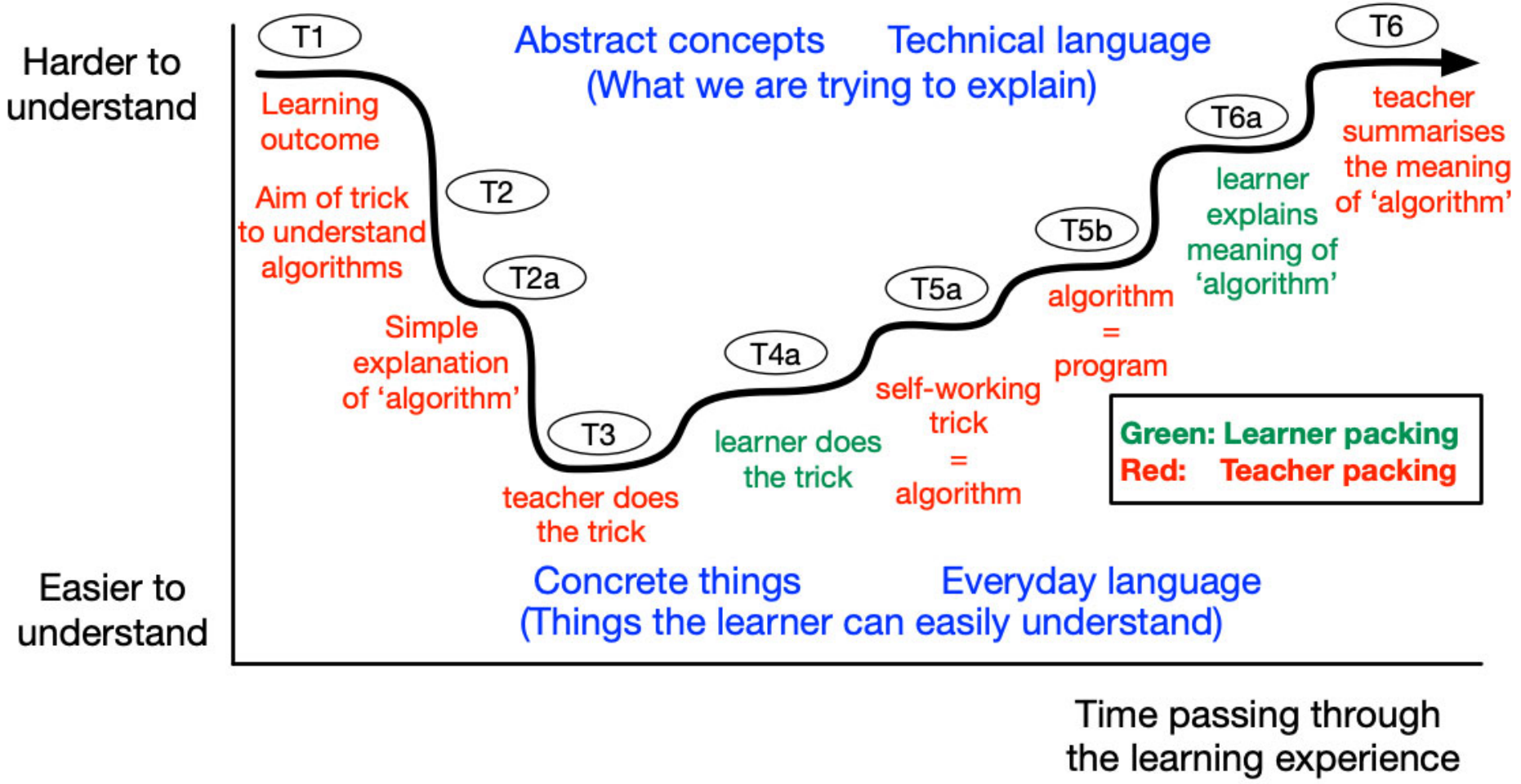
Actual original presentation



What I almost did by accident



Final Version



Summary of the method

- The method was very quick and easy to follow
  - I did it on the morning of the talk as part of last minute preparation!
- It found clear ways to improve lesson plans
  - More unpacking and repacking
  - Add learner rather than teacher activity

Other points

- Unpacking and repacking is proving important for us
  - Lots of ways to do it?
  - Who does the packing matters!
- Layers of activity, different routes
  - Physical enactment is a deeper layer than metaphor

Back to Jane
and some discussion

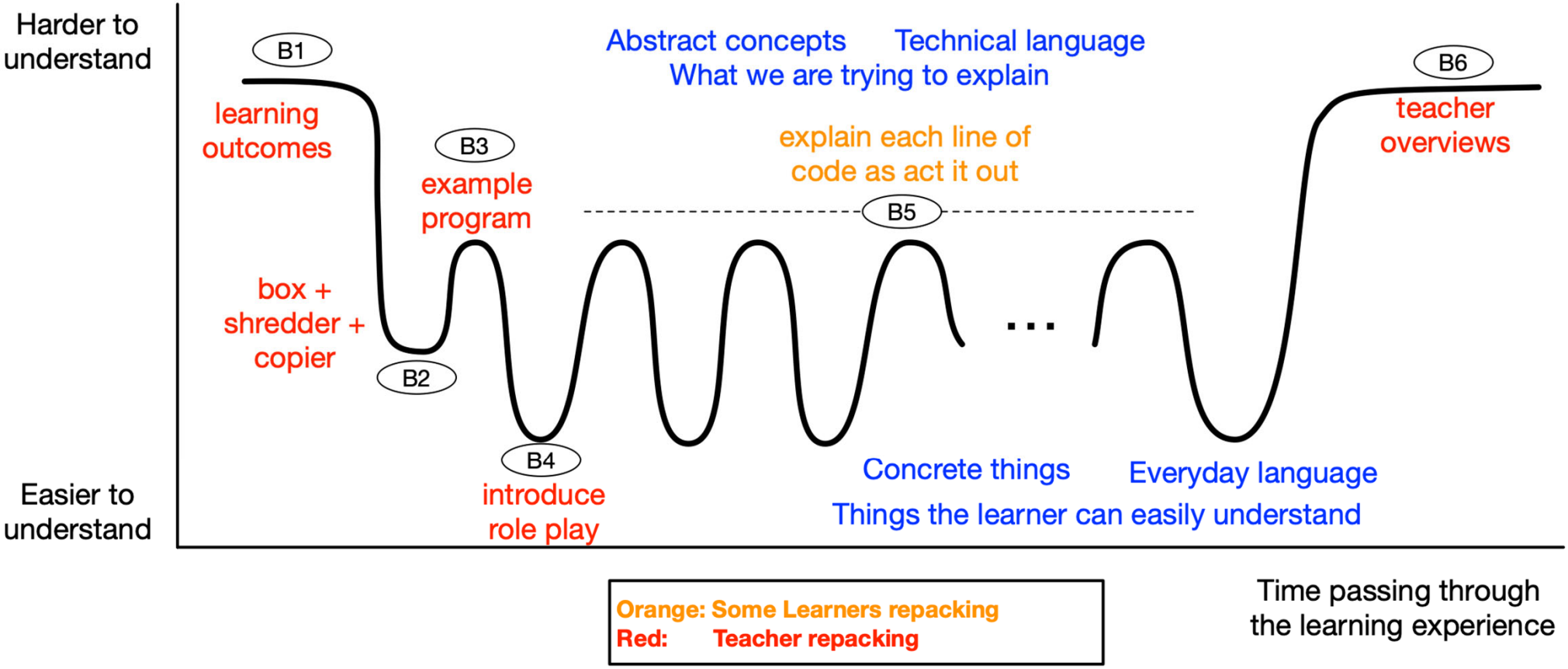
Different paths

- I’ve been thinking more about the detail of providing good learning experience…

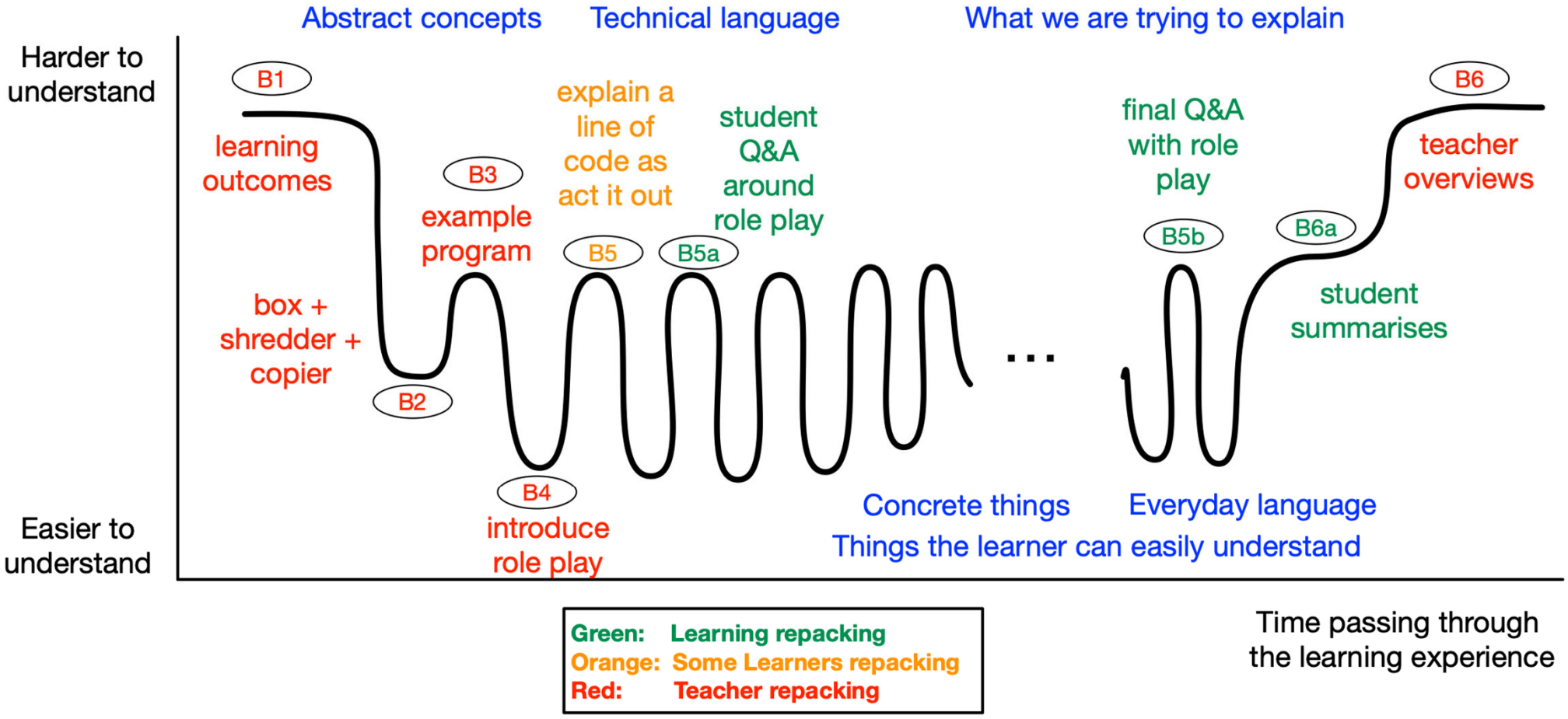
Box Variable

- Another activity I analysed prior to delivery then adapted was the Box Variables activity
- Aim to teach about program variables and assignment
- Physical Role play of computation using a metaphor of variables as boxes with integrated copier and shredder.

Original Plan's profile



Final Profile



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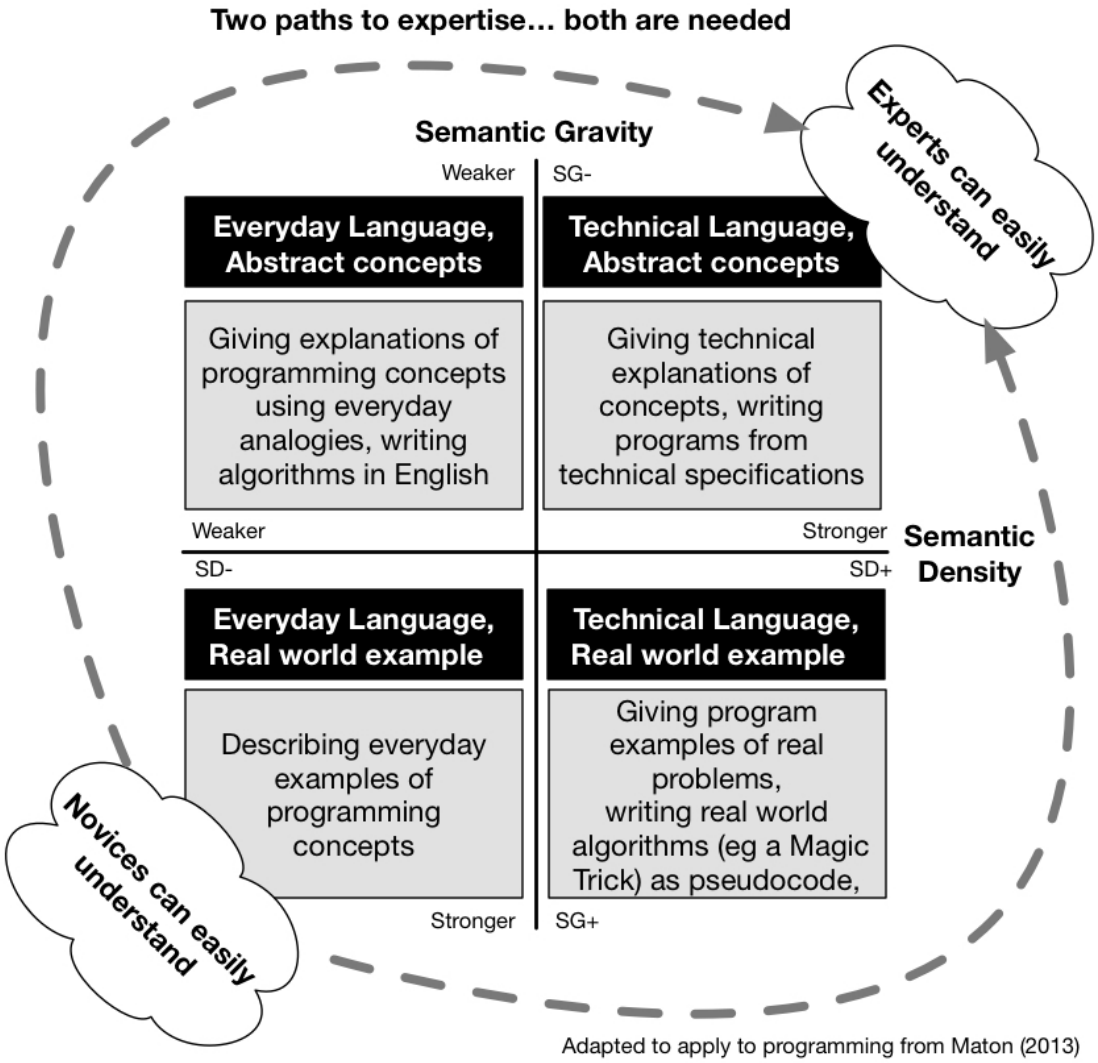
Two paths to expertise

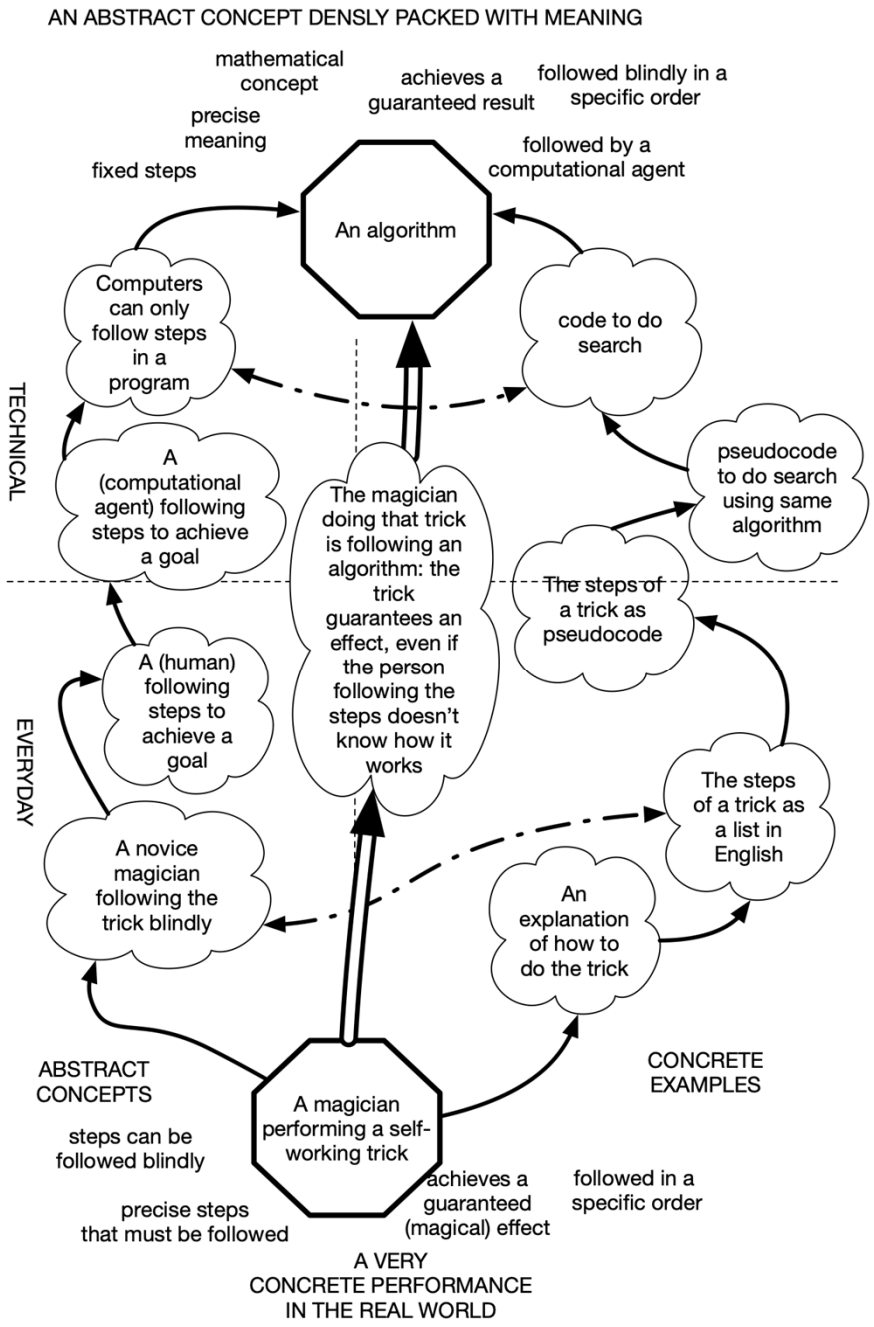


Inspired by Black 2014

Lots of paths to expertise

...

layers and ladders



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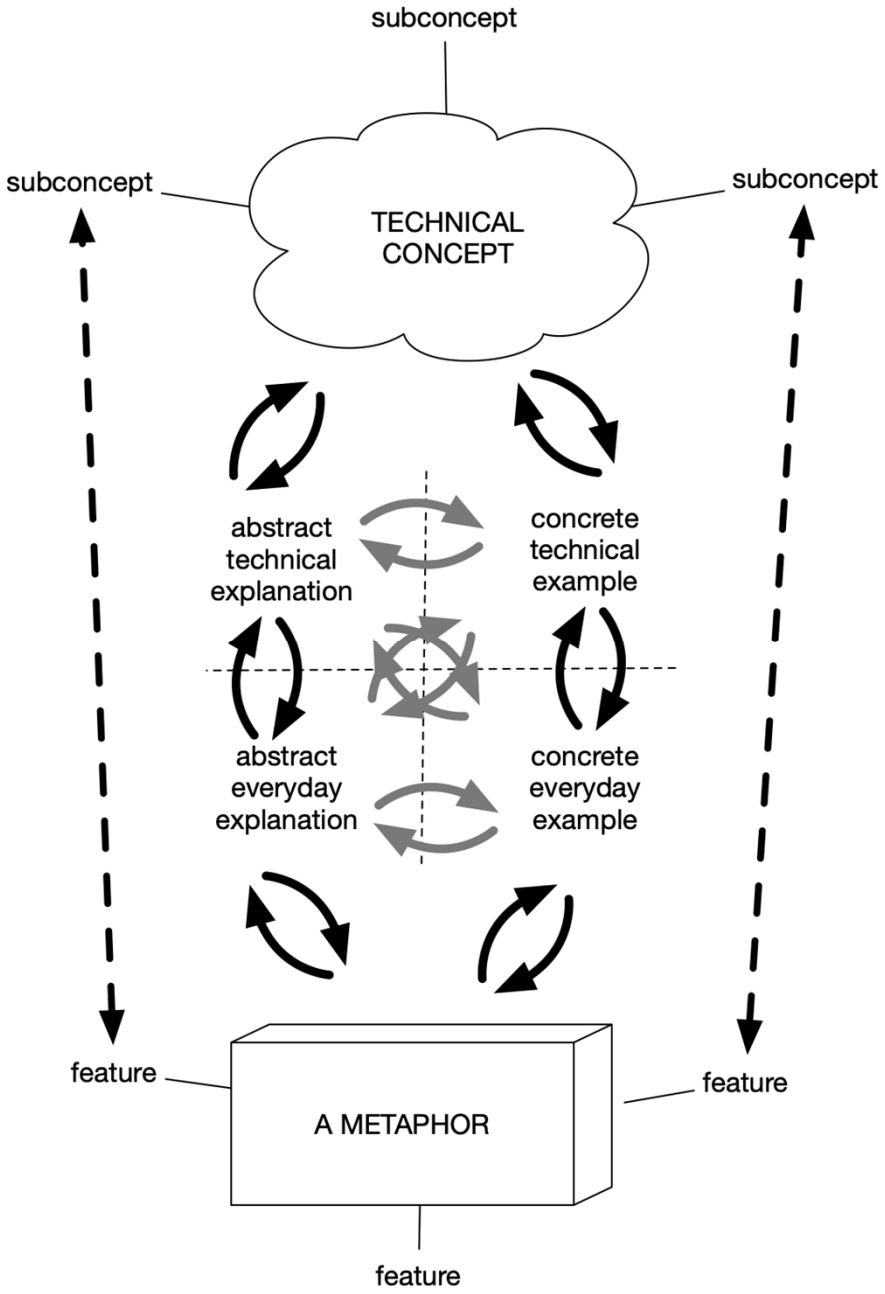
Linking metaphors with concepts



All related resources at
http://bit.ly/LCTSeptWebPage

Thank You