Semantic Waves

Analysing the Effectiveness of Computing Activities

Paul Curzon*, Jane Waite* and Karl Maton**
* Queen Mary University of London
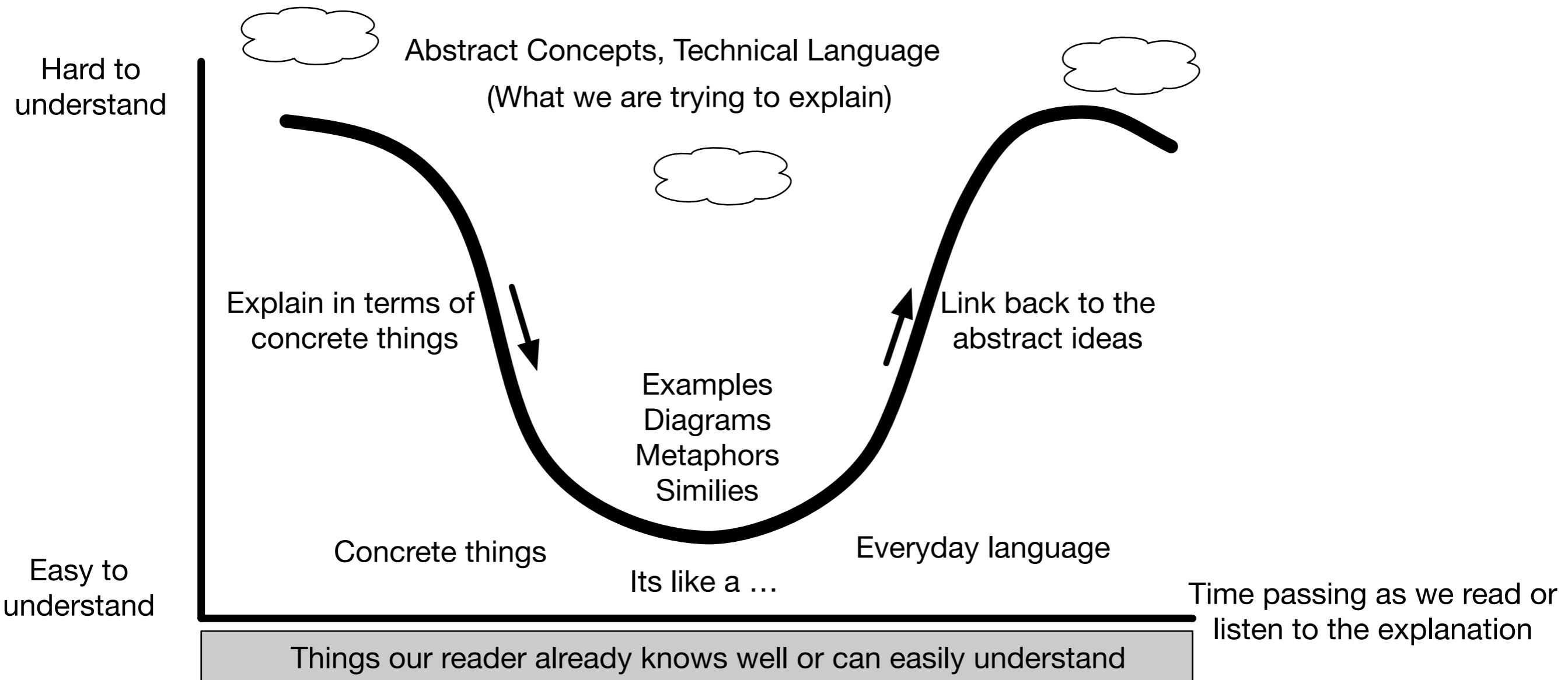** The University of Sydney

Background

- Computing is now being taught in schools worldwide

- There is little experience of solid pedagogy

- We need simple tools to help judge the effectiveness of learning activities

- Semantic waves give an educational tool that may help

Semantic Waves

- An educational theory by Maton (2013), http://legitimationcodetheory.com/:
  - a simple but powerful theory of **how to teach concepts**.

- It has been successfully applied across MANY disciplines.
  - We have applied it to Computing (Curzon et al, 2018, Curzon, 2019, Waite et al, 2019, Curzon and Grover, to appear).

- A way to think about what a good explanation / learning experience is
  - whether written, multimedia or spoken.

- A way to think about why metaphor and unplugged teaching works (and why sometimes they might not).

- It can be used as a way to evaluate lesson plans, online resources, and as a way to teach students how to write good explanations.

A good learning experience follows a wave pattern

Hard to understand

Abstract Concepts, Technical Language
(What we are trying to explain)

Explain in terms of concrete things

Link back to the abstract ideas

Examples
Diagrams
Metaphors
Similies

Concrete things

Everyday language

Its like a …

Easy to understand

Time passing as we read or listen to the explanation

Things our reader already knows well or can easily understand
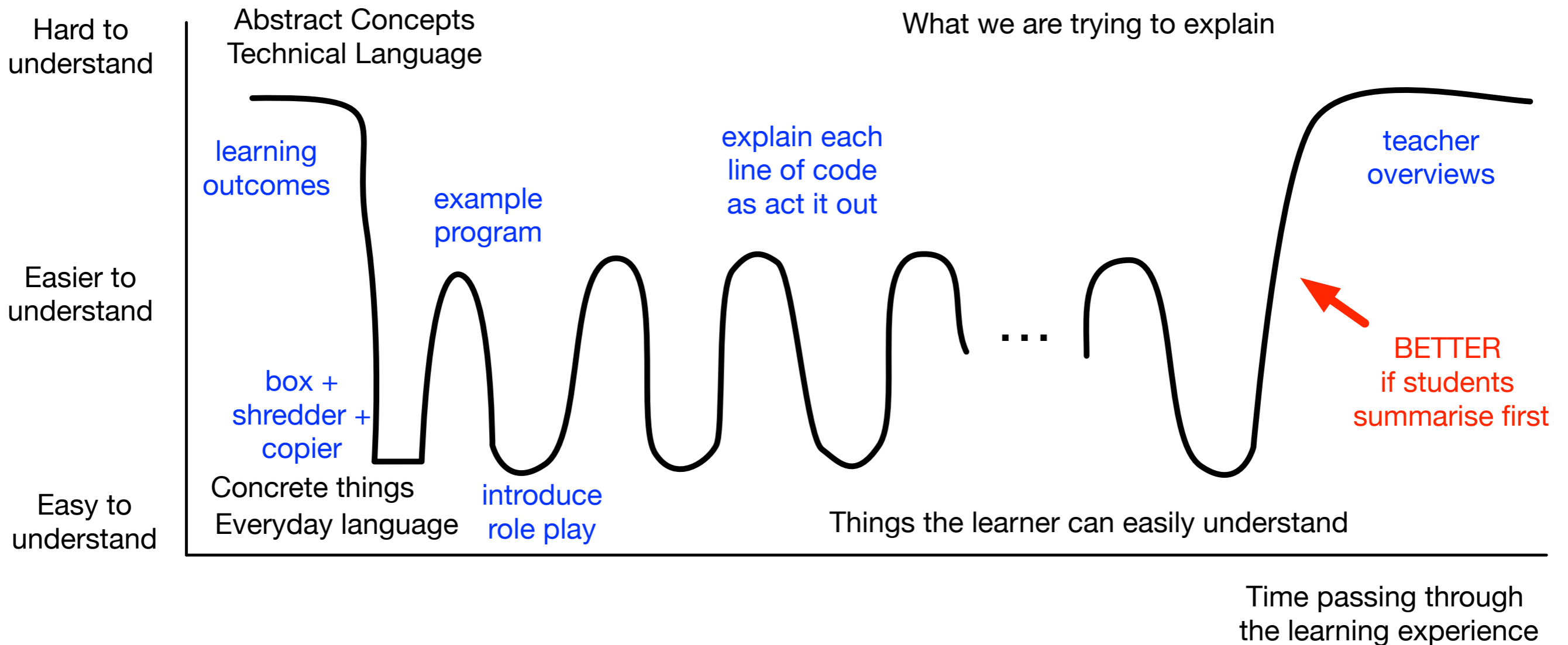
Method

- We applied semantic wave theory to two (more recently more) activities / approaches to teaching programming

    1. The cs4fn / Teaching London Computing unplugged activity:

        "Box Variables"

        - an activity that has been very effective over many years

    2. A "copy code" activity

        - suggested as an ineffective way to teach programming

- We also asked teachers to draw the wave structure of activities while they happened as part of a CPD session.
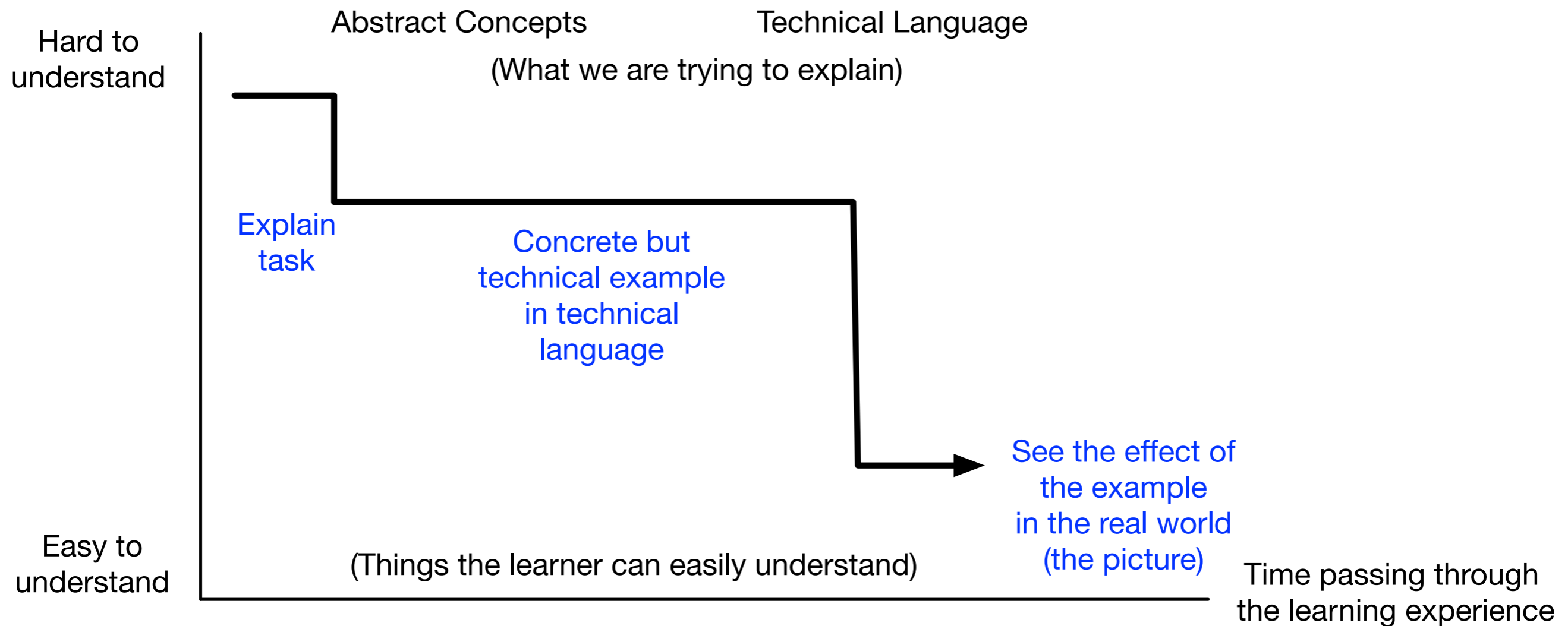
Findings

- The Unplugged activity had a "good" wave within wave structure that unpacked and repacked concepts repeatedly.

- The copy-code activity had a "poor" flat-lining down escalator structure with no unpacking or repacking.

- In both cases the reflecting on the wave structure suggested improvements

  - eg adding a student repacking activity at the end of the Box Variables activity

Box Variables:
Waves within waves

Hard to understand

Abstract Concepts
Technical Language

What we are trying to explain

learning outcomes

example program

explain each line of code as act it out

teacher overviews

Easier to understand

box + shredder + copier

BETTER if students summarise first

Concrete things
Everyday language

Easy to understand

introduce role play

...

Things the learner can easily understand

Time passing through the learning experience

The Copy Code Activity: Stepped Down Escalator

Hard to understand

Abstract Concepts   Technical Language

(What we are trying to explain)

Explain task

Concrete but technical example in technical language

See the effect of the example in the real world (the picture)

Easy to understand

(Things the learner can easily understand)

Time passing through the learning experience

Conclusions

- Semantic Waves provide a quick and simple but powerful way to evaluate learning activities

- It gives insight in to why they may work or not

- It supports reflective changes to improve activities

- Teachers were able to plot wave structure of activities while watching them

References

P. Curzon, P.W. McOwan, J. Donohue, S. Wright, and D.W. Mars (2018) Teaching Computer Science concepts. In Computer Science Education: Perspectives on Teaching and Learning in School, S. Sentance, E. Barendsen, and C. Schulte (Eds.). Bloomsbury Publishing, London, Chapter 8, 91–108.

P. Curzon (2019) Follow Semantic Waves, Tip 9 of *Learning To Learn To Program.* https://teachinglondoncomputing.org/learning-to-learn-to-program/ An informal blog on practical ideas about teaching programming.

P. Curzon and S. Grover (to appear), Guided Exploration for Introducing Programming Concepts through Unplugged Activities, chapter in a forthcoming book.

K. Maton. 2013. Making semantic waves: a key to cumulative knowledge-building. Linguistics and Education 24, 8-22 (2013).

Jane Waite, Karl Maton, Paul Curzon & Lucinda Tuttiett (2019) Unplugged Computing and Semantic Waves: Analysing Crazy Characters, Proceeding of UKICER – The UK and Ireland Computing Education Research Conference, University of Kent, Canterbury, UK, September. ACM. DOI: 10.1145/3351287.3351291

Thank you…
Questions?

Paul Curzon (p.curzon@qmul.ac.uk)

teachinglondoncomputing.org/semantic-waves

http://legitimationcodetheory.com/

Twitter: @cs4fn