Barefoot

Semantic Waves

Semantic Waves are a simple way to visualise how we build knowledge. The theory was developed by an educational researcher, Karl Maton, and has become popular across the world to review and improve learning activities in many different teaching contexts [1]. For example, semantic waves have been used to review the teaching of nursing in universities and to improve history lessons in secondary schools. Recently, Crazy Characters, a favourite Barefoot activity, was analysed in terms of its semantic wave, this was the first time that the theory had been applied to a computing lesson [2].

In this short article, we introduce you to semantic waves and we hope you will 'draw' some of your lessons to help you review and improve your teaching. This is not only relevant for the teaching of computing of course.

1) What are semantic waves?

A semantic wave is a simple diagram or a drawing which represents the planned knowledge building about a concept within a learning activity.

2) How do you work out how to draw a lesson activity using semantic waves theory?

Simply put, there are two questions we need to ask ourselves when we draw an activity:

Vocabulary: Are we using technical vocabulary or everyday vocabulary to talk about the concept we are learning about?

Context: Are we talking about the concept in a non-specific abstract way or in a specific context?

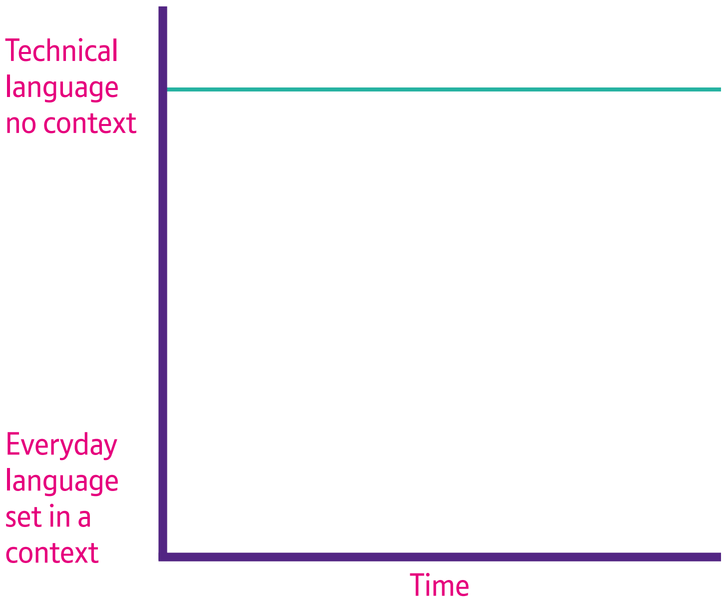
3) What do the axes on the diagram represent?

- The horizontal axis represents time.
- The vertical axis represents whether the vocabulary is technical or everyday, and whether the activity is set in a context or not.

Let's look at some examples to make this clearer. In these examples, we are reviewing a short activity in which a teacher is introducing algorithms to primary pupils.

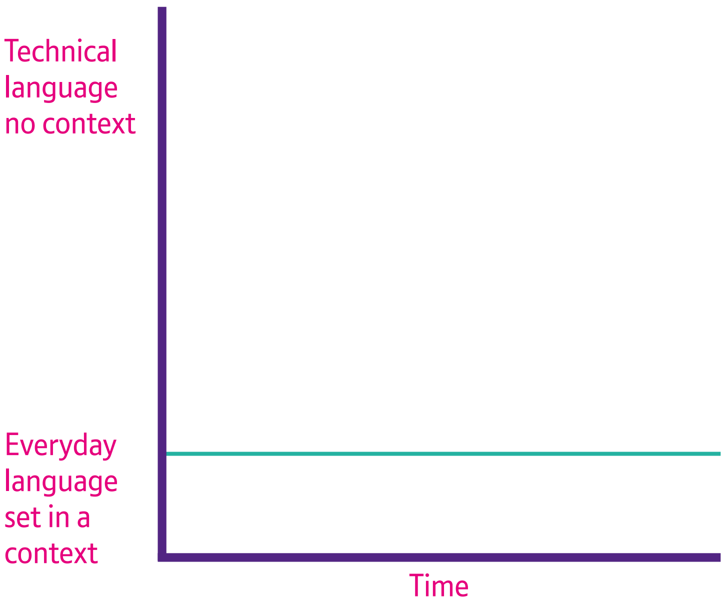
In Example 1, we have a flat line at the top of the graph, where the language is technically complex and there is no context. For example, the teacher might say "Algorithms are a precise representation of a process which must be entirely unambiguous so that any information-processing agent, when executing it, is guaranteed to produce an identical output". She might go and explain what execution is, what an information-processing agent is, and what an output is. All without using everyday language or by giving examples.

Example 1

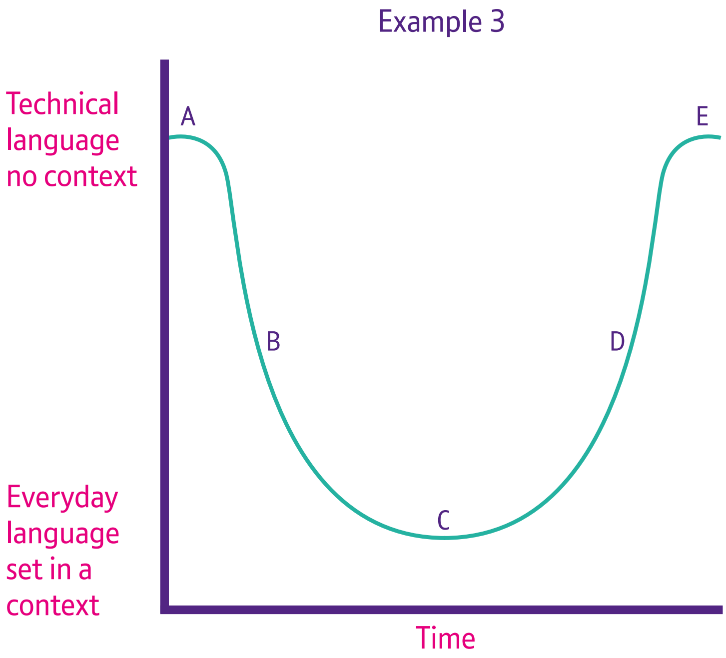


In Example 2, we have a flat line again, at the bottom of the graph. Here the activity is using everyday language set in a specific context. For example, again using our algorithm example; the teacher might just give examples of algorithms, but not say they are algorithms and at no point link this back to theory. For example, she might give the children verbal instructions on how to draw a crazy character, then ask them to make their own instructions. Next, she might ask the learners to get their friends to follow the instructions. At no point during the practical activity, might she mention algorithms or emphasise the importance of precision.

Example 2



In the final diagram, (Example 3), there is a wave. This wave represents an activity which starts using technical vocabulary not set in a context, then moves to using everyday language in a context, and finishes with technical vocabulary and no context.



In our algorithm example, the teacher might start by explaining that children are going to learn about algorithms (part A of the diagram).

The teacher then might ask learners what they know about this technical term and say that she is going to explain with an example. The wave is now descending (part B), making a clear link from theory to the context-specific example.

Next, the teacher might say she has some simple instructions, an algorithm, for drawing a crazy character and ask the learners to follow these. Then she might ask learners to create their own instructions and ask their friends to follow the instructions. Throughout the practical activity, she might draw children towards the realisation that the instructions need to be precise and unambiguous in order for their friends to draw the character that was intended. This practical part of the activity is using everyday language and is set in the context of drawing characters (part C of the diagram).

To ensure that learners ‘repack’ this new understanding that algorithms must be precise and unambiguous. The teacher asks what the children now know about algorithms from undertaking the activity. This ‘repacking’ is the ascent of the line on the semantic wave diagram (part D). Here the children are linking the context-specific everyday language experience to a general technical understanding. It is important that learners “repack” for themselves, rather than teachers doing it for them.

Finally, (part E of the diagram) we might ask children for a general definition of an algorithm, and hope the children have a more technical understanding and that they understand an algorithm needs to be a precise and unambiguous representation of an activity.

According to the underlying theory of semantic waves, learning is more effective if a teaching activity is a wave shape rather than a flat line. In the wave, learners are building knowledge by explicitly linking technical abstract concepts to everyday language and practical experiences. Learning is not seen as a single wave but as a series of interlinked waves, and waves within waves.

Can you match the following descriptions of elements of different lesson plans to parts of a semantic wave?

1) Pupils melt ice, watch steam condensing on a mirror from a boiling kettle and put water in a freezer to make ice.
2) Pupils draw a mind map of what they know about states of matter with relation to water.
3) Pupils verbally describe the different states of matter for water.
4) The teacher reads out a definition of states of matter.
5) Pupils complete maths problems such as $2 + 1 \times 3 = 5$ and $(2 + 1) \times 3 = 9$
6) The teacher asks students what they know about brackets and the order of operations for addition and multiplication.
7) Pupils explain what function the brackets perform and about order of operations to their friends using examples they have made up.
8) In art, students are asked to mix red and yellow paints and create a piece of artwork depicting a sunset and then to describe what they did.
9) Pupils are asked what they know about colour mixing in context of using red and yellow to make a sunset picture.
10) Pupils are asked to read a description of the colour wheel.

Answers to questions

1) This activity is using everyday vocabulary set in the context of exploring water. Part C on our semantic wave.
2&3) These elements could be B or D activities on our semantic wave, learners are unpacking or repacking what they know about water and states of matter.
4) This could be an A or E element of a semantic wave.
5) This is a practical activity using specific values and examples (Part C).
6&7) These elements could be B or D activities on our semantic wave, learners are unpacking or repacking what they know about brackets and operations with relation to addition and multiplication.
8) This is a Part C activity, pupils are undertaking a practical activity in a specific context of mixing one pair of colours and using this to create a specific outcome. However, as they come to describe the activity, some learners may use more technical vocabulary and start to talk generally about colour mixing so they would be working in Part D.
9) This could be a part B or D activity as they are either unpacking or repacking their knowledge.
10) This could be an A or E element of a semantic wave.

If you would like to find out more about semantic waves, read Paul Curzon's summary of using semantic waves to teach programming [2], read the NCCE quick read on semantic waves [3] or read the research paper on applying semantic waves to Crazy Characters [4].

1 Knowledge Building. Educational studies in Legitimation Code Theory, Karl Maton, Susan Hood & Suellen Shay, 2015 ISBN 9780415692335

2 Semantic Waves, Paul Curzon 2019, Teaching London Computing https://teachinglondoncomputing.org/semantic-waves/

3 NCCE, Improving explanations and learning activities in computing using semantic waves, 2019 https://raspberrypi-education.s3-eu-west-1.amazonaws.com/Quick+Reads/Pedagogy+Quick+Read+6+-+Semantic+Waves.pdf

4 Unplugged Computing and Semantic Waves: Analysing Crazy Characters. Jane Waite, Karl Maton, Paul Curzon, and Lucinda Tuttiett. 2019. DOI: https://doi.org/10.1145/3351287.3351291