SEMANTIC WAVES AND CRAZY CHARACTERS

Reviewing a lesson activity using semantic waves

Crazy Characters is a free online lesson plan which introduces algorithms to primary pupils using an unplugged activity. It is one of the free resources available from the Barefoot website (helloworld.cc/crazycharacters). In the activity, learners are asked to follow verbal instructions (see Figure 1) to draw a crazy, made-up character. The instructions are not very precise, so that learners can then improve the algorithm. Following a whole-class activity, learners then design their own algorithm in order to draw their own crazy character.

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KARL MATON

Karl is the director of the LCT Centre for Knowledge-Building at the University of Sydney. Karl is the creator of Legitimation Code Theory (LCT), which is being widely used to shape research and practice in education, sociology, and linguistics.

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Where did Crazy Characters come from?

In 2012, Michael Gove disapplied the English ICT Curriculum, creating a two-year hiatus while we, primary teachers, awaited a new statutory ICT curriculum.

In the meantime, we were still required to deliver the old curriculum, or to start to teach what we thought might come next. I [Jane] recall being at BETT, the big computing education trade show, as the announcement was made, and then frantically searching for resources and people who could help me rewrite my school's ICT subject planning. I recently found my first revised scheme of work, which I created for September 2012 – there was no mention of algorithms, but there were learning objectives such as, 'I can predict the results of someone else's instructions.'

Many computing lesson plan versions later, in spring 2014, I applied for a secondment from my school and for a job as a content author on the Barefoot Computing Programme. Managed by the British Computer Society (BCS), the initiative was funded by the DfE and BT, and was one of the first of many successful, innovative, and crucial Computing at School (CAS) programmes to support teachers in their delivery of computer science in school. Very luckily, I got the job and my life changed completely.

Over the next year, the Barefoot team developed resources that demystified the computer science elements of the new computing curriculum. Using an iterative approach, we wrote concept documents and their associated classroom activities, publishing as we went along. The algorithms concept was first, and I was tasked with thinking of an introductory unplugged activity. In June 2014, Crazy Characters was born.

Crazy Characters was one of the first resources on the new Barefoot website, part of the very first continuing professional development (CPD) presentation, and is still a staple of the Barefoot volunteer workshop delivered to teachers in schools. When writing the activity, I was keen to make sure

SEMANTIC GRAVITY EXAMPLES

An activity with weaker semantic gravity would be to ask learners to memorise a definition of an algorithm without any context, such as 'an algorithm is a set of precise rules or steps to solve a problem'. Semantic gravity would become stronger by adding an example, such as 'an algorithm is a set of precise rules or steps to solve a problem, such as an unambiguous set of steps to draw a square'. This activity has now shifted from weaker to stronger semantic gravity. It would be strengthened further if learners then engaged in a practical activity of creating algorithms to draw squares in which the need for sides of equal length was explored, to highlight the importance of precision.

that it was easy to run in class, fun, and, most importantly, gently introduced this new word 'algorithm' by doing, rather than telling.

I built on the way in which I normally taught instruction writing in literacy, which included a spot of curiosity, teachers getting things wrong, humour, and peer review. I had no idea that five years later I would be asking Professor Karl Maton, a leading education researcher, to review the lesson plan and to investigate my planning in terms of semantic waves.

Semantic waves – what are they?

I was introduced to semantic waves by Professor Paul Curzon, who has written about their potential for teaching programming (**helloworld.cc/curzonblog**). The notion of semantic waves is part of a wider theory called Legitimation Code Theory or LCT, created and developed by Karl Maton (**helloworld.cc/maton2013**). Very simply put, we can use semantic waves to review learning activities, and abstract the process of learning to better think about how learners develop an understanding of knowledge. The overall aim is that, by doing this, we can reflect on and improve teaching experiences for our students. To explain these ideas, I need to briefly outline two concepts introduced on pages 46–47: semantic gravity and semantic density.

Semantic gravity explores the context of meanings, and how much of meaning depends on the social context to make sense. So where meanings are more concrete (such as practical examples, or those from personal experience), semantic gravity is stronger; where meanings are more abstract (such as theory), semantic gravity is weaker. Changes in semantic gravity can be shown over time, such as when teachers or students move from theory to examples, or from practical activities to a concept.

SEMANTIC DENSITY

An activity asking learners to 'follow the instructions to draw a square' would have weaker semantic density than one requiring learners to 'follow the algorithm to draw a square'. This is because the first activity is less complex, as the term 'instruction' has a less complex meaning than the term 'algorithm'.

Semantic density explores the complexity of meanings. Where meanings are relatively simple, such as something that is described in everyday language, semantic density is weaker; where meanings are more complex, such as in the case of technical concepts, semantic density is stronger.

We can depict changes in semantic gravity and semantic density as a semantic profile; an example is shown in **Figure 2**.

> "SEMANTIC GRAVITY EXPLORES THE CONTEXT OF MEANINGS AND LOOKS AT HOW MUCH MEANING DEPENDS ON THE SOCIAL CONTEXT TO MAKE SENSE

In this example from teaching biology, the teacher begins by discussing a scientific concept in abstract and technical terms. The teacher and students then unpack some of its meanings in everyday language, through practical and concrete examples. Finally, the students repack those examples into technical terms by completing a table of concepts. This moves from abstract and complex meanings down to more grounded and simpler meanings, and then back up to abstract and complex meanings. These movements up and down are called semantic waves, and a rapidly growing body of research is showing that they are crucial for knowledge-building in classrooms. Study after study is showing that waves enable knowledge to be built, while flatlines (such as continuous description or incessant theorising) hinder knowledge building. These insights are now feeding into teacher training, curriculum planning, and classroom practice.

Figure 1 Teachers read out their algorithm for how to draw a Crazy Character Credit: Jane Waite

Enough of the theory — we now need a concrete example, so we are going to strengthen our own semantic gravity!

Creating the semantic profile for Crazy Characters

I contacted the creator of semantic waves, Karl Maton, asked him if he could help me create a semantic profile for a resource, and suggested Crazy Characters, as it is very familiar to me, is still very popular with teachers, and was also due for a review.

In an online hang-out, Karl read the lesson plan, and together we walked very carefully through each step of it and drew up the semantic profile. We profiled the plan as though a teacher was following the plan to the letter.

What does the semantic profile for Crazy Characters look like?

The semantic profile for just the introductory part of the Crazy Characters lesson is

A USEFUL LINK

To get the most out of this article, download the Crazy Character lesson plan and walk through it with us: **helloworld.cc/crazycharacters**.

shown in **Figure 3**. It is broadly a U-shape, but with steps coming out of the U. We will now go through each of the lesson plan steps and explain the wave.

SIGNALLING To start with, the teacher is asked to explain to students that a special new word is going to be used. Learners are signalled that something important is coming, that a concept high up the semantic profile is on the way. Learners are NOT provided with a definition at this stage. Instead, curiosity and expectancy are kept high, so they can form their own understanding of the term later through the practical experience. There is no practical concrete activity going on here, so semantic gravity is weaker.

CONCEPT INTRODUCTION The term 'algorithm' is introduced as the teacher starts to use the word. The teacher should NOT explain what the word means at this point. There is no practical activity here (weaker semantic gravity), but it is clear that the term is a complex and technical one (stronger semantic density).

CONNECTING In the plan, the teacher is instructed to say that they are going to use the algorithm now. This clear connection of the concept to the activity is very important. The connection enables learners to add the knowledge they gain during the practical activity to their emerging understanding of the meaning of the concept. As shown in **Figure 3**, the semantic profile line drops, like a bungee rope, as we connect the theory

ADVANTAGE

Some research indicates that learners from more socially advantaged homes may be more comfortable with semantic waves than students from less advantaged homes, who may experience less semantic waving. The rationale is that some learners are more likely to have generalised and complex meanings explained to them, from a very young age. In other words, the 'why' question gets answered, and experiences are provided that exemplify the 'why'.

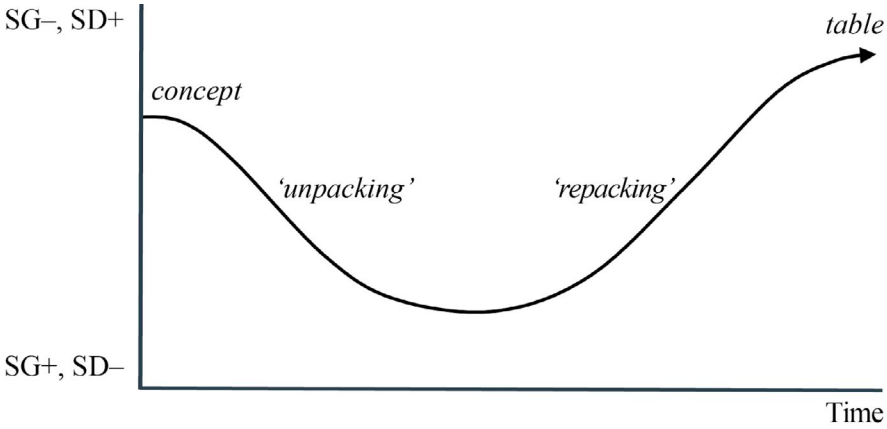

Figure 2 This example of a semantic wave comes from biology teaching (Maton, 2013) Credit: Karl Maton & Jane Waite

to the practical activity (strengthening the semantic gravity as the context is introduced). If there was no connection, the line on the profile would break.

CONCRETE ACTIVITY Next, the teacher is asked to read out the steps to enable the learners to draw the crazy character. The wave is low on the profile: it is a concrete activity (stronger semantic gravity) and likely to be expressed through relatively simple meanings (weaker semantic density), unless learners start to use the term 'algorithm'. If this were the case, there would be little spikes of semantic density.

COUNTER-EXPECTANCY The teacher is asked to be very vague with the instructions given to learners. The aim is that when they ask the pupils to share their drawings, the images will be very different, and they can say that they did not expect this to be the case, and ask why. This is called counter-expectancy. This means that the context in which the learners are developing their understanding is challenged and alternative options are raised. This increases the meaning of the concept. On the semantic profile, this is shown as a step up (widening the context weakens semantic gravity; adding meaning strengthens semantic density).

STAGED RETURN Next, the teacher is instructed to ask the learners how they could improve the algorithm. Learners start to think about making the algorithm more precise, but this is still in a relatively specific context. On the graph, this shows as another step upwards (adding meaning strengthens semantic density).

PACKING Finally, the lesson plan instructs the teacher to ask a generic question of 'What was the algorithm?' This is a more general view of the activity, requiring the learner to 'repack' their accumulated understanding from the practical activity. Again, this is moving up the profile, further away from a specific context, and adding more meanings (reducing context weakens semantic gravity).

THE REST OF THE LESSON We have not profiled the rest of the lesson for this article. Broadly, it follows a similar set of patterns. However, the highly prescriptive nature of the introduction is loosened as the learners create their own Crazy Character algorithms. Included in this is the introduction of a further concept, that of debugging, as they ask their friends to implement their algorithms as drawings and then, together, debug the algorithm in order to produce the same imagined character.

How has creating the semantic profile been useful?

By drawing the semantic profile for Crazy Characters with Karl Maton, I have had the opportunity to apply semantic waves from theory to practice. This experience has provided a number of useful outcomes.

Firstly, it has introduced me to a language that has helped me describe

the lesson plan. Secondly, and more importantly, semantic profiling has enabled me to analyse and reveal why the learning activity worked. It showed how ideas were introduced in a concrete way and more complex meanings were gradually added, stepwise, to develop a more general and abstract understanding. Thirdly, the process has supported my review of the activity, helping me think of ideas to improve and build upon the lesson plan. Finally, I have concluded that semantic profiling is a practical and useful approach that I will continue to explore and use when designing teacher professional development, and in creating lesson planning material.

Would you like to change Crazy Characters?

To maintain the semantic wave I would like to add a follow-on lesson that applies in a programming context what was learnt in this unplugged lesson. I would also like to reorder the learning intentions to match the Use–Modify–Create theory (**helloworld.cc/umc**) and I would increase the use of the term 'design', following my own research area.

However, overall, I would not change the main steps of the Crazy Character lesson plan. By creating the semantic profile, I have revealed how the plan provides a carefully scaffolded learning experience to help learners develop an understanding of the meaning of the algorithm concept. As shown in **Figure 3**, the lesson plan includes a signal that a new concept is to be taught, introduces the concept, connects theory to a concrete activity, incorporates a concrete activity, and increases the meanings condensed within the concept to reveal a 'packed' (complex) definition of the concept.

Working with Karl Maton on reviewing Crazy Characters has been thoroughly enjoyable. I am indebted for the time he has kindly spent supporting me in writing this article. I would also like to thank Lucinda Tuttiett, who read through the article and helped keep it real!

SEMANTIC PROFILES

Does all this mean that the profile for Crazy Characters will always be the same?

No. The profile is likely to be different each time it is delivered. We have analysed the lesson plan as though it is delivered to the letter of the plan. Teachers are likely to change how they deliver the lesson, so the semantic profile will be different each time they deliver it. Similarly, different learners will engage in an activity in different ways. This will mean that each learner experiences a different personal semantic profile based on their own knowledge-building event.

I now have a fledgling understanding of how semantic waves can be used to reflect on and develop teaching activities, and we hope that by sharing our semantic profile of a popular lesson plan, we will help others learn about this approach. (HW)

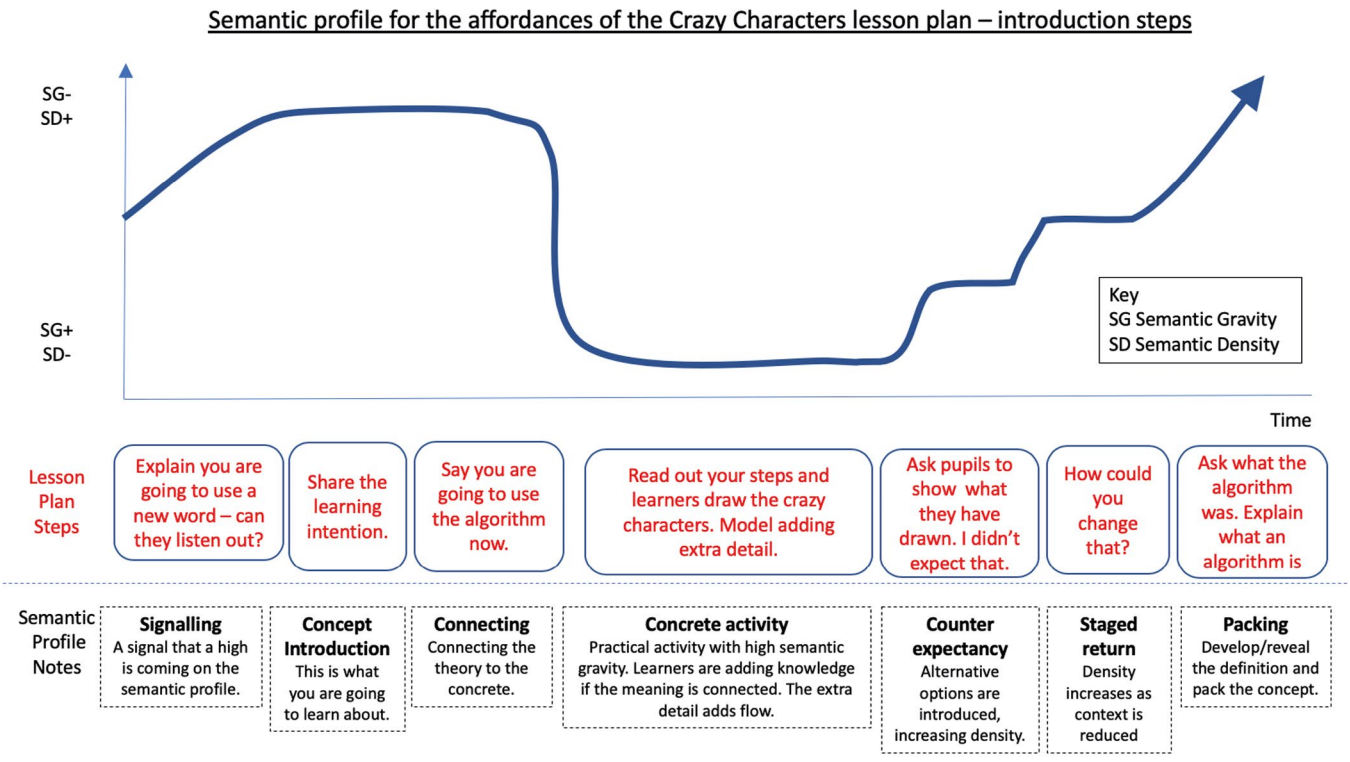

Figure 3 This is the semantic profile for the Crazy Characters lesson plan (introduction only)

Credit: Karl Maton & Jane Waite