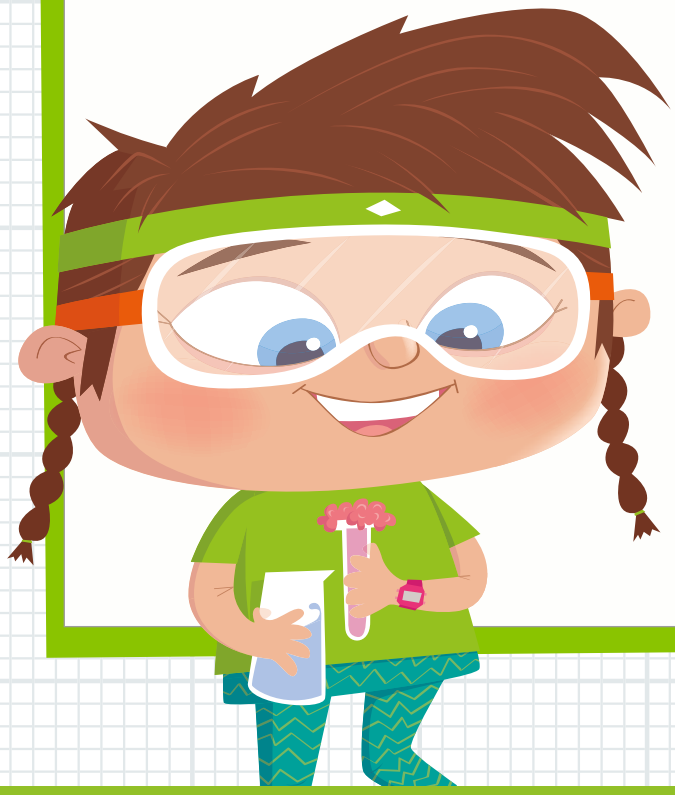
Academic evidence behind the Science Bug approach

1. Instil confidence and inspire future scientists: ensuring teacher confidence

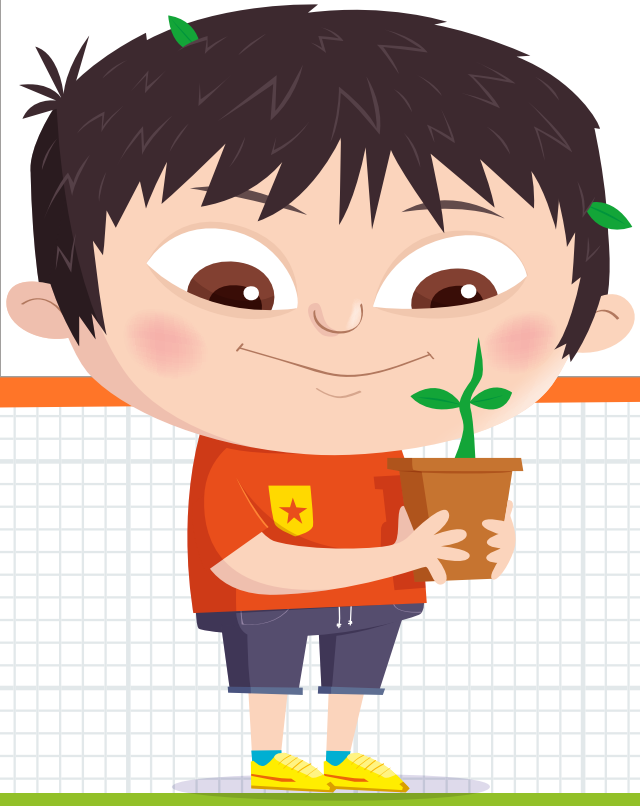
Harlen. *Science as a key component of the primary curriculum: a rationale with policy implications. Perspectives on Education Primary Science 1.* (Primary Science) 2008.	This paper highlights the fact that, as children go up the primary year groups, children's interest in science decreases due to lack of teacher confidence especially in later Key Stage 2. 'There appears to be a continuing trend for young people's attitudes to school science to become less positive as they move from primary school and into secondary school (…) primary teachers have been characterised by a lack of confidence in their knowledge and competence to teach science.'
Beggs, Melton, Murphy & Russell. *Primary Horizons, Starting out with Science.* Wellcome Trust. 2005.	This paper highlights the declining interest in science in the later primary years and the high number of primary teachers who lack confidence in their teaching of the current science curriculum. It also recognises that it is important to develop children's acquisition of scientific concepts and life skills. 'Primary science education should of course not just be concerned with knowledge, but also with the acquisition of scientific concepts and the development of scientific and thinking skills (…) Ultimately it should seek to develop the sorts of skills that will help young people to become active and informed citizens as well as equipping them with the underpinning conceptual knowledge.' 'Children's early years are key to shaping society's attitudes towards science. By the time children reach secondary school, they will have experienced seven years of schooling and will have well-developed attitudes to science'.



Murphy and Beggs. *Primary Science in the UK A Scoping Study*. 2005.	This report looks at the current status of primary science in the UK and ways to improve it so children will be better supported in their development of scientific skills. It had similar findings to the above Primary Horizons, in terms of teacher's lack of confidence in their teaching and the need to make science more relevant to a child's life. 'Young children's natural curiosity can be harnessed in their science lessons. It is during science that they have the opportunities to manipulate materials, ask questions, hypothesise, predict and test their predictions. They can express what they have learnt through drama, writing, talking, drawing and by using ICT.' 'If the teacher's understanding is not good, s/he 'covers' the topic from a text and encourages children to 'learn' it. On the other hand, when the teacher has a high level of understanding of a topic, s/he encourages questions from children, explains and promotes active learning.'

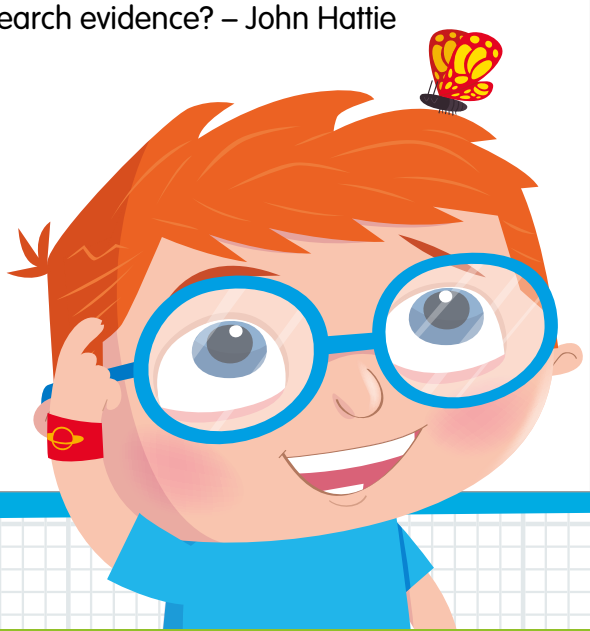
2. Hands-on, awe-inspiring science

Ofsted. *Successful science, an evaluation of science education in England 2007-2010*. 2011.	This report looks at the strengths and weaknesses of science across primary and secondary schools, noting that on the whole, practice is better in secondary schools. It also focuses on outstanding teaching and how to improve practice from satisfactory to outstanding, highlighting the need for more hands-on science that will really engage children in the subject. 'The most important focus for schools is to ensure that pupils are engaged and challenged by their work in science, particularly in scientific investigation and how science works.'

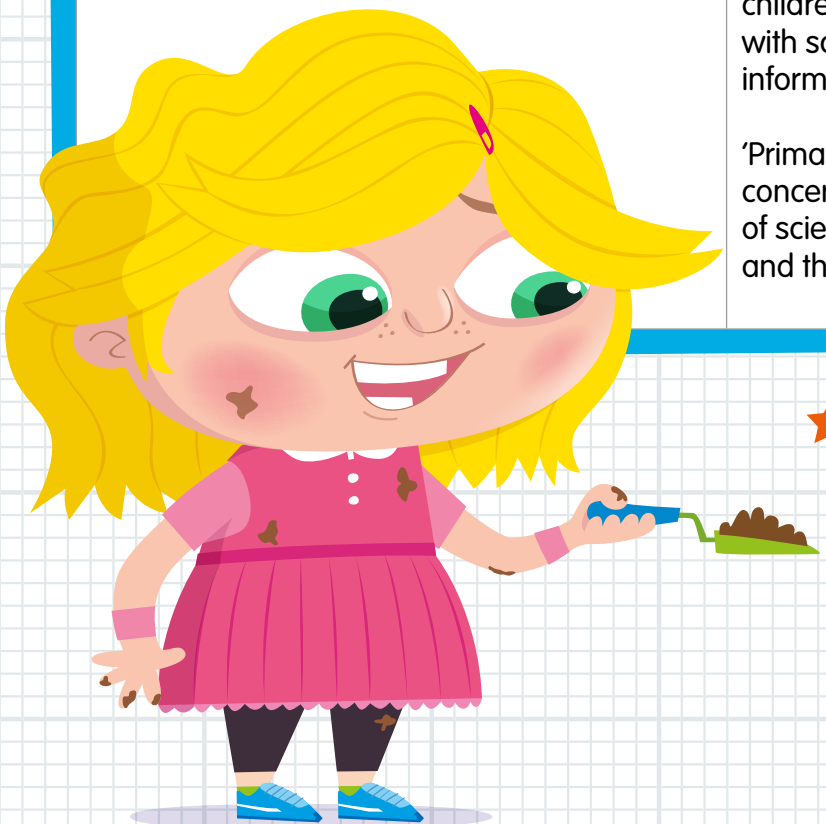


CBI. *Tomorrow's World – Inspiring Primary Scientists*. 2015	This recent report from the Confederation of British Industry (CBI) highlights that teachers don't have the subject knowledge/confidence and the subject isn't getting the time it needs at primary school. This means children are switched off science and don't take it up later on at school/university. Therefore there will be problems with the pipeline of scientists needed in the future. 'The need to enthuse and excite young people about science is critical…'

3. Teaching and learning cycle

Carr et al. The constructivist paradigm and some implications for science content and pedagogy. 1994.	**1. Introduction and knowledge capture** This paper highlights the importance of the constructivist view of science teaching as opposed to the traditional behaviourist view. Every child comes to a new topic with some ideas and the need to investigate if they are right or wrong and if their views have changed at the end of a topic. It recognises that the children will be more engaged in the content of a lesson if they are able to relate it to their lives and interests. 'The context in which we learn something affects the way that individuals construct knowledge. Learning about a scientific concept may be much easier through contexts with rich links to students' interests.'
Teachers Make a Difference: What is the research evidence? – John Hattie 	**2. Develop understanding: direct teaching** Hattie believes that teachers are the source of greatest influence on student achievement (apart from the students themselves). He explores the power of the teacher and argues that we must focus on improving teaching to reach greater student achievement. '…we should focus on the greatest source of variance that can make the difference – the teacher. We need to ensure that this greatest influence is optimised to have powerful and sensationally positive effects on the learner.'

Coe, Aloisi, Higgins and Elliot Major. *What makes great teaching? Review of the underpinning research*. Sutton Trust. 2014.	This paper looks at what makes great teaching, what tools we can use to capture great teaching and sustain it and how great teaching can promote better learning. The six components of great teaching are: content knowledge, quality of instruction, classroom climate, classroom management, teacher beliefs, and professional behaviours. 'The most effective teachers have deep knowledge of the subjects they teach, and when teachers' knowledge falls below a certain level it is a significant impediment to students' learning. As well as a strong understanding of the material being taught, teachers must also understand the ways students think about the content, be able to evaluate the thinking behind students' own methods, and identify students' common misconceptions.'
Beggs, Murphy, Melton & Russell. *Primary Horizons, Starting out in Science*. Wellcome Trust. 2005.	**3. Apply understanding** This paper highlights the importance of ensuring children stay fully engaged in science. Teachers need to have the scientific content and skills knowledge, and ensure that children apply their understanding and practise their skills. 'Teachers view making science more relevant to children's everyday lives as key to engaging them with science and helping them to become active and informed citizens.' 'Primary science education should of course not just be concerned with knowledge, but also with the acquisition of scientific concepts and the development of scientific and thinking skills.'



Black and Wiliam. *Inside the Black Box.* 2001	**4. Reflect and review** This paper focuses on formative assessment standards in the 'black box' situation in the classroom. It decides formative assessment standards should be raised and gives evidence for how to improve it. 'All those activities undertaken by teachers, and by their students in assessing themselves(…) provide information to be used as feedback to modify the teaching and learning activities in which they are engaged.'

4. Assessment

Harlen. *Developing policy, principles and practice in primary school.* 2012	This report proposes an assessment framework for science in primary schools. It outlines how pupil's attainment should be collected and used and proposes the continued use of formative assessments throughout the year by teachers. ' …assessment by teachers is the most appropriate form of assessment for science in the primary school. One of the key aims of science at this stage is to enable children to 'work scientifically', something that cannot be assessed by external written tests alone. Teachers can observe pupils when engaged in science investigations and ascertain their understanding by listening, questioning and looking at their work.'
Black and Wiliam. *Developing the theory of formative assessment.* 2009.	This paper aims to provide a rationale for defining formative assessment: the aim being to open up further enquiry and help teachers implement more effective formative practice. 'Our approach indicates that any evidence of formative interaction must be analysed as reflecting a teacher's chosen plan to develop learning, the formative interactions which that teacher carries out contingently within the framework of that plan – as realised in the social world of the classroom and school – and the internal cognitive and affective models of each student of which the responses and broader participation of students provide only indirect evidence.'