Children's gestures can help us understand their ideas as Carol Callinan and John Sharp explain

STUCK FOR WORDS

Figure 1 What do children's gestures tell us?

How many of you reading this now have seen children pausing, sitting back, sighing, waving their arms around and generally appearing to be stuck for words? Have you stopped to ask yourself what this means? What are children trying to tell us when they can't find the words that they need? Children's gestures are valuable in informing teaching practice and how we go about assessing children's work in science.

The importance of children's errors, misconceptions and preconceptions in science education has become well established through a wide body of research conducted since the 1970s (for example see Vosniadou, 2008, for a recent review). In the UK, the highly influential Children's Learning In Science (CLIS, 1987) and Science Processes and Concept Exploration (SPACE, 1989–1998) projects reminded us not only that children's ideas often differ from those of scientists or what is taught in school, but that these can strongly influence the direction of future learning. Popular authors including Driver, Osborne and Harlen (Hodson, 1998), to name but a few, have all significantly helped to progress our understanding of how children learn science inside and outside the classroom. This in turn has highlighted the need to consider carefully not only *what* we teach but also *how* we teach it and *when*.

Gestures and children's ideas

CLIS and SPACE focused on collecting children's ideas using mainly interview techniques combined with drawings and concept maps. Subsequently, concept cartoons have become a popular way of eliciting ideas in many classrooms. However, we should also consider the use of non-verbal cues and clues, particularly if the child is not able to tell us what they know, so we can better understand the underlying and unspoken mental model that a child is applying to science tasks. For example, a child discussing how an electrical circuit works may be unable to find the words to describe their ideas and what they think, but

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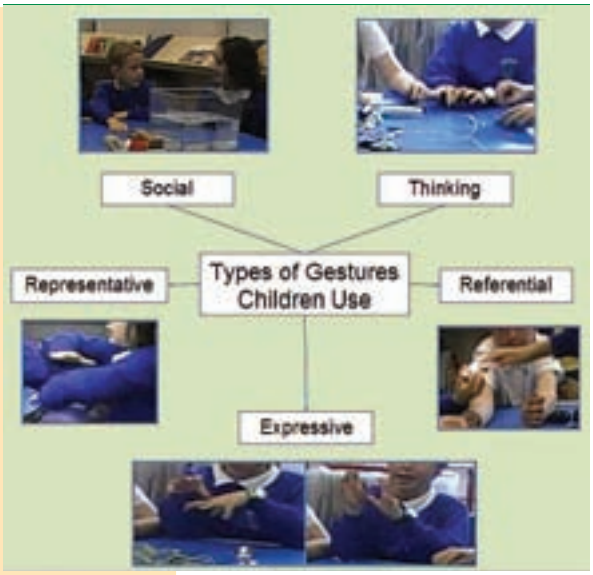

Figure 2 The types of gestures that children use

Figure 3 A referential gesture – pointing at an object to illustrate an explanation of the flow of electricity

may use their hands to trace a path from the battery to the bulb and back to the battery. Without considering gestures we may be underestimating what children know and can do.

To find out more, we not only investigated children's ideas in conventional ways during routine classroom-based activities, but also explored in detail children's gestures and what they might mean (Figure 2). The activities, 'electricity' and 'floating and sinking' (Box 1) in years 2 (ages 6–7) and 6 (ages 10–11) were chosen specifically because they are rich in children's alternative explanations. In all cases, the activities were video-recorded for obvious reasons.

Early analyses suggest that gestures can be classified into two overarching categories: scientific and social. Each of these types of gesture provides unique opportunities to consider in greater depth the ideas that children have in relation to the science concepts explored.

Scientific gestures

The scientific gestures can be used to enhance the ideas expressed in speech or can serve as carriers of meaning which go beyond what is said in words. It is perhaps this second type that offers us most insight into children's ideas. In our studies, we have encountered at least four different types of scientific gesture that children use:

- **referential;**
- **representational;**
- **expressive;**
- **thinking.**

Referential

Children frequently use referential gestures, which include pointing to objects, pictures or people, to complete their discussions. Alan, a year 2 child engaged in constructing a simple circuit, used a referential gesture to indicate the presence of an object that was not readily observable as he discussed why a bulb in the circuit lights up. His pointing gesture, directed at a bulb in a simple circuit, was accompanied by the question: '*Is it because there's a little metal thing in there?*' The use of this gesture indicated his awareness of the functional role that unobservable 'objects' play within electrical circuits (Figure 3).

Representational

While referential gestures appear to enable children to link their discussions directly to props within the science classroom, we found that sometimes, rather than indicating objects directly, children would act out the behaviour of objects using their hands. We called these 'representational' gestures, which appear as 'charades'; the hands are used to represent an object, an event or the interaction between things. One year 2 child, Mary, frequently used representational gestures as she worked through her ideas about floating. She used both hands, one to represent the object and one for the liquid, in this case water, in which the object was floating. Her hands were positioned one above the other, both palms facing downwards. The lower hand, which represented the water, remained stationary and the top hand was gently lowered towards the stationary hand before being brought to a stop on top of the lower hand. We interpreted this representational gesture as her explaining that the water remains stationary while the object is lowered into it, and that, once in place, the object is supported by the water and remains above the surface. In Figure 4 a boy is representing his ideas similarly.

Box 1 The activities that were analysed

Electricity

This activity consisted of:

- an initial discussion of what children think electricity is;
- circuit construction;
- grouping and testing materials that conduct or insulate;
- a role-play analogy using Smarties to represent electron movement in a circuit.

Floating and sinking

This activity consisted of:

- an initial discussion of what children think causes some objects to float and sink;
- grouping and testing materials;
- a plasticine modelling activity in order to explore children's approaches to making it float;
- a practical demonstration of upthrust and water displacement using an inflated balloon.

Expressive

If representational gestures are used to show the behaviour of things, expressive gestures, which include repeated movements or emphasis, are used by children to demonstrate values such as the strength of responses. In one example, Joe, a year 6 (11-year-old) child, cupped his hands, and then repeatedly moved them apart through a sideways motion, to indicate how he thought a bulb would brighten if more batteries were added to a circuit.

Thinking

Thinking gestures appear to include behaviours such as finger drumming, head holding and face and hair stroking. In our study, Joe was discussing his ideas about electricity. As he did this he repeatedly paused and drummed his fingers on the table. This type of behaviour can often be seen as a disruption to group or class work. However, we interpreted this as Joe's non-verbal method of signifying that he was considering his own ideas before making a response.

Social gestures

It might be easy to ignore social gestures, as these occur across all teaching contexts and can be very important for raising awareness of when children require social support or are seeking confirmation of their ideas. However, they might also be subject specific.

Joe provided a good example of how children use social gestures to express uncertainty and attempt to elicit help from other group members. During one activity, and following a question, he removed his hands from the table, placed them on the seat of his chair and sat on them. He then pursed his lips and slowly and deliberately looked to the child on his right and then the child on his left. When he received no response from the other children, he lowered his eyes to the table. Once the activity moved on and a different question was asked of him, Joe raised his eyes and moved his hands back to the table. This appeared to be Joe's non-verbal way of letting us know that he was unable to offer an answer initially, but was still happy to contribute when he felt able to.

Looking to other group members can also be a 'check' on whether there is social agreement on ideas that are being discussed. Daniel did exactly this when discussing his ideas about floating. He began to speak, paused mid-sentence, looked in turn at each of his neighbours and, after receiving no response from them, continued. This was Daniel's non-verbal way of saying '*Is this all right?*' and '*Do you agree with me?*' Social gestures such as these in science lessons can help us to understand what children know, what they are capable of doing and how understanding is negotiated in groups.

Implications

Of course, not all children gesture and some children gesture only occasionally, but the results of our research are beginning to show that, for those that do, there may be very real and practical applications of exploring this form of communication.

So the next time a child in your science class starts to wave his or her arms around, ask yourself '*Are they seeking help or trying to explain something but don't have the words?*' before you tell them to behave. This apparent disruption may have more meaning attached to it than is at first apparent. Use such gesturing to learn what children know and can do, beyond what their speech conveys, and to assess and evaluate their work.

Figure 4
A representational gesture – using hand gestures to explain ideas about floating to peers

References and further reading

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Carol Callinan is a PhD student and **John Sharp** a professor of education and head of research at Bishop Grosseteste University College Lincoln. Emails: carol.callinan@bishopg.ac.uk; john.sharp@bishopg.ac.uk

If you have had first-hand experience of children using gestures in your classroom, particularly if you had the feeling that they may have been used to represent something other than what was immediately evident in language, the authors would love to hear from you. In addition, if you find yourself using non-verbal gestures in your teaching and you think these help you to illustrate ideas to children or further facilitate learning then tell us about that too. We hope to develop a database of experiences that will help us to explore the extent of the use of gestures in typical classroom settings.