Young children's ideas about measurement:

What does a kindergarten student consider 'measuring' to be?

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In this article Amy MacDonald asks us to reconsider the starting point for teaching measurement concepts. We are sure readers will enjoy looking at the drawings and reading of the implications for teachers of young children. We are certain that if you teach young children you will want to try the "Draw yourself measuring task".

In March 2010, the first draft of the K–10 Australian Curriculum for Mathematics was released for comment and review, and the newly-framed curriculum has been progressively developed since that time. While changes were ongoing since the initial draft, among the persistent features of the mathematics curriculum were its three strands, including a single strand labelled Measurement and Geometry. Within this strand, children learn to make meaningful measurements of quantities, choose appropriate metric units of measurement, understand connections between units, and calculate derived measures (ACARA, 2010). Clearly, measurement is a key component of the mathematics curriculum, and teachers of young primary school students may spend considerable time developing lessons to introduce measurement concepts to the children in their class. However, it is important for early years educators to recognise that when children start school, they may have already developed their own ideas about what 'measurement' is and how the process of 'measuring' may be carried out. A recent study (see, for example, MacDonald, 2010; 2011) investigated the measurement understandings children bring to school, and the out-of-school contexts that influenced the development of these understandings. As one of the data gathering activities in the study, children aged between four and six years and in their second week of Kindergarten (the first year of primary school in NSW) were asked to "Draw yourself measuring," and to provide a description of their drawing. These drawings and descriptions

provided insight into what these Kindergarten children considered 'measuring' to be, and showed the ideas about measurement that the children had developed prior to starting school.

According to the literature

Typically, 'measurement' is defined as a process by which a number is assigned to an attribute of an object or event (National Council of Teachers of Mathematics, 2000). Mathematics education researchers have recognised that children's understandings of measurement begin to develop in the prior-to-school years (Clements & Stephan, 2004). The literature suggests that at about three years of age, children know that continuous attributes such as mass and length exist, although they may not be able to measure them accurately. By about four or five years of age, children begin to make progress in measuring quantities and start to use words which represent quantity of a certain attribute.

Although researchers debate the order in which measurement concepts are developed, they tend to agree that the fundamental ideas of measuring are *attributes*, *comparisons*, and *units* (Stephan & Clements, 2003). Typically children begin with informal measuring processes and units, before measuring using formal tools and units. As such, young primary school students generally learn to measure with informal implements such as hands, feet, pencils, and so forth, rather than using formal tools like rulers and tape measures. However, as the following section will show, there is evidence to suggest that young children are more familiar with the use of formal processes of measurement and as such, the starting point for measurement teaching and learning activities may need to be reconsidered.

According to the children

When the children were asked to complete the "Draw yourself measuring" task, almost all of the children had some idea of what 'measuring' might be. Indeed, of the 49 children who completed the "Draw yourself measuring" task, only one child was unsure of what 'measuring' was, stating, "I don't know what measuring means." This is an important point, because this indicates that most children come to primary school having already developed some ideas about measurement. Interestingly, the majority of the drawings explicitly focussed on *length* measurement, despite the general nature of the task. This may indicate that when asked generally about measurement, most children automatically relate 'measurement' to 'length measurement'. Consequently, the examples presented herein largely constitute examples of length measurement only.

'Finding out'

Many of the children were able to explain what they thought 'measuring' meant, and for the most part, children described 'measuring' as being 'finding out' about an object. This involved finding out about a particular attribute of an object, such as finding out how

Figure 1. Ella's drawing.

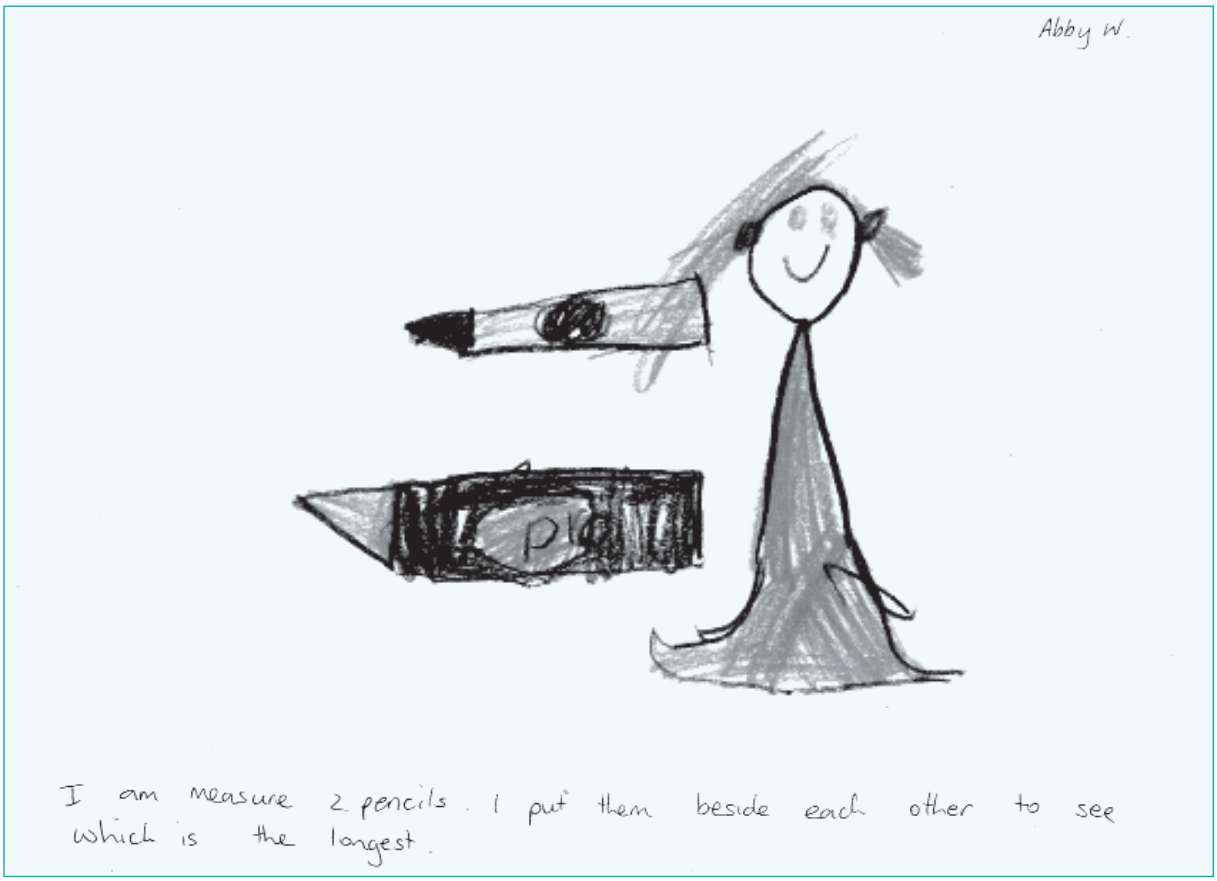

Figure 2. Abby's drawing.

long or how tall an object is. For example, when asked to describe his drawing, William said, "I measured my family to see how big they are. I tried to find out how high they are when I look at them." Caitlin also talked about measuring to "find out" something, describing her drawing as, "A brick wall and my Mum. She is measuring it to find out how big it is, with a measuring tape."

In relation to the typical measurement development sequences, it was clear from the drawings and descriptions that these children were able to identify measureable *attributes* of objects. Importantly, the children were also able to use language appropriate to the attribute being measured. For example, Ella (Figure 1) described her drawing as, "I've got a measuring sheet at home. That's me measuring myself. I'm seeing how tall I am." Clearly, Ella understood that the term 'tall' is appropriate language to use when describing length measurement.

Process of 'finding out'

In addition to describing that they were 'finding out' about an attribute of an object, the children were able to describe processes of 'finding out'. Some of the children described using *comparisons* to find out about objects. For example, Kody described his drawing as, "This is me against a big rock. The rock is bigger." Based on his drawing, Kody appeared to be examining the relative heights of both himself and the rock using a common baseline. Another example of comparative length measurement was provided by Abby (Figure 2), who explained, "I am measuring two pencils. I put them beside each other to see which is the longest."

A small number of children described what could be considered *informal* processes of measurement, whereby they used informal tools such as pencils and sticks to measure. Typically, these informal processes were still centred on comparisons; that is, comparing the object being measured to the informal measuring tool of choice. For example, Willis described his drawing as, "I'm measuring a tree with a rope to find out how tall the tree is. I'm seeing if the tree's longer than the rope." However, a far greater number of children in fact described using *formal* measuring tools,

such as rulers and measuring tapes. For example, Imogen explained, "I'm measuring a piece of paper. I'm getting a ruler. I'm finding out how long it is," while Tallulah said, "I'm measuring a tree with my tape measure to see how tall it is."

In addition to having an awareness of formal measuring tools, many children also showed an understanding of using measuring tools to determine *quantity,* and connect quantity to *unit*. Indeed, many of the children's drawing showed measuring tools which had been partitioned into units, for example Chloe's drawing (Figure 3), which she described as, "I'm measuring a dog with a measuring tape to find out how big it is". It can be seen in Chloe's drawing that the measuring tape has been used to determine a measurement of "5". Having determined a measurement, some children were able to connect the measured quantity to a formal unit (although, this was typically done in an inappropriate manner). For example, Kyra was able to explain, "I am measuring Mrs M. I use a pencil to draw a line against a measurer with a giraffe on it at my house. She is six metres tall!" There were also somewhat unusual examples of connecting quantity to unit, such as Brodie's drawing of himself measuring the ages of two whales, which he described as, "I'm measuring the daddy whale and the baby. The baby is five years old like me; the daddy is 78."

Implications for teachers

The examples presented here have shown that children arrive at school with their own understandings about measurement. These examples demonstrate, in particular, what Treacy and Willis (2003) describe as "protoquantitive comparison"—that is, an ability to use words such as "big" and "lots" to make quantity comparisons. Many of these understandings are well-developed, and align with the big ideas which teachers typically aim to introduce in classroom measurement-learning activities. In particular, the *Australian Curriculum: Mathematics* suggests that in the first year of school, teachers would be seeking to develop children's ability to directly compare objects, and use appropriate measurement language (ACARA, 2012). Some of the insights from the drawings may provoke teachers to

Figure 3. Chloe's drawing.

reconsider the ways in which they might plan and implement measurement-learning activities. For instance, children may already be familiar with the direct comparison of objects, so it may be beneficial to expand this understanding to indirect comparisons or multiple comparisons. Furthermore, some children may be familiar with formal measuring tools and units when they come to school, so it may be beneficial for teachers to build on this familiarity rather than use only informal means of measuring. However, while the examples presented in this article demonstrate that some children may be coming to school with instrumental understandings about measurement, it is important for teachers to not overlook the development of relational understandings. That is, as Skemp (2006) has identified, there is a difference between "knowing what to do" (instrumental) and "knowing what to do *and why*" (relational). Clearly, it is important for teachers of young primary school children to understand the knowledge about measurement which children have already developed for themselves so that this knowledge can be built upon and further developed. The "Draw yourself measuring" task is a simple way that teachers can find out children's ideas about measurement at the start of school.

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