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# Learning and development: mathematics – marking time.

Elizabeth Carruthers and Maulfry Worthington

*Children's mathematical graphics* is a term used to describe when children choose to use their own marks and representations to explore and communicate their mathematical thinking. The term *'children's mathematical graphics'* is based on our analysis of over 700 examples, in which children from two to seven years old explored their mathematical thinking. These marks can include scribble-marks, drawings, writing, tally-type marks, invented and standard symbols including numerals, as children make their own personal mathematical meanings.

**Figure 1**: *Alfie's paper calculator*

This play began several weeks earlier when Mason was playing with a real calculator: he seemed to be using it as a digital game, pressing the buttons and commenting excitedly "Fighting games! Video games!" It was Mason who first decided to use a small notebook to make 'paper calculators', explaining as he tore off a sheet, "This is a *different* calculator with computer games on".

When children choose their own symbols, graphics and layouts to help their mathematical thinking, they understand what they are doing because they have explored their own thinking processes. This links with foundation stage profile point 8: 'uses developing mathematical ideas and methods to solve practical problems'. Children's own problem solving is at the heart of *children's mathematical graphics.*

**Figure 2:** *Scoring goals – 'A cross means you lose'*

**Figure 3:** *'This is where you double lose'*

The 2008 *Williams Mathematics Review* stressed:

- that 'effective early years pedagogy values and supports children's own *mathematical graphics'*
- there needs to be **'** A culture with a significant focus on mathematical mark-making in line with early writing through, for example, role-play and the use of popular mathematical mark signage in the environment.'
- the importance of 'a learning environment that encourages children to choose to use their own mathematical graphics to support their mathematical thinking and processes' (DCSF, 2008b).

Many teachers in schools ask the children to 'record' their mathematics usually for example, after the children have used practical equipment such as multilink. Such recording activities do not support and extend children's own thinking indeed in many cases it can just be copying what they have already done. This can result in low level thinking. *Children's mathematical graphics* is about children using graphicacy to support their thinking about their mathematics. It encourages high level thinking.

The recent publication of *Mark Making Matters* (DCSF, 2008) has raised the profile of young children's ability to use marks, symbols and drawings to make and communicate their personal meanings and ideas. At the same time, focusing on 'mark making' raises important questions about how teachers and practitioners might best understand and support children's explorations.

**Meaning making and *children's mathematical graphics***

*Children's mathematical graphics* originate in the meanings they explore, make and communicate in their imaginative (symbolic) play; meanings that are vitally important children's cognitive development.

Vygotsky first identified the relationship between imaginative play, meaning making and writing: he showed how children use gestures, actions, speech and resources as signs to 'mean' something. Studies of 'meaning-making' are known as 'semiotics', and more recently Gunther Kress has shown how children explore their ideas as they make meanings with 'lots of different stuff'. For example, in one nursery Jemima handed the practitioner a flat stone to which she had added grass and gravel, explaining 'Here's your dinner'.

Pretend play contexts such as role play and 'super-hero' play provide especially rich opportunities as children use resources they find to stand for something else. Although at first children's meanings may not always be transparent, when sensitive adults 'tune into' children's imaginative play, children's complex thinking become clear. Tuning into and valuing children's meanings, helps adults understand and further support children's thinking.

Junk modelling and 'cut-outs' also offer rich possibilities for children to explore and communicate meanings. For example, in the nursery a group of boys chose to play 'paper calculators' over the course of two terms. They made marks on pages of small notebooks, tearing off each page as another calculator as their ideas about technology and video games developed Their talk was very rich as they pretended to operate their gadgets and shared and negotiated meanings about Batman and other super-heroes, about numbers on calculators and about the buttons they used to control their games and calculators.

Playing with meanings in freely chosen play contexts allows children to understand that marks and symbols can also carry meanings. For example, in their drawings young children often notice the zigzag shapes made by cutting with pinking shears, and name them 'crocodiles. Children's ability to make and attach personal meanings to marks also provides a significant window into children's drawings and emergent writing and is recognised by the *Early Years Foundation Stage*. In the examples here, the children used different media and resources to create their 'signs'.

This research places new emphasis on young children as powerful meaning-makers, exploring their thinking and meanings in ways that make personal sense as they come to understand the abstract language of 'written' mathematics.

**Observations from nursery and Reception: children exploring symbols**

**Finn's story**

Finn (aged three and three quarters) was very interested in his age. He discussed this with his nursery teacher and friends. He wanted to be four as his friend were already four. After a discussion with his mum at home he came into the nursery and told his nursery friends and teacher he was ‘three and three quarters’. He said ‘I’m not three, I’m three and three quarters…look this is how you write three and three quarters’ (figure 3). Then he said ‘This is how you write three and a half’ (figure 4). This was Finnian’s personal symbol for something extremely important to him - his age, therefore this is a real context for his mathematical development. He was exploring the concept of nearly being four and attaching symbols to that meaning. The open dialogue between his teacher and friends was vital to his thinking: this dialogue continued over several weeks and the nursery children made many more examples of their very own fractions.

**Figure 4:** *Finn’s fractions (a)*

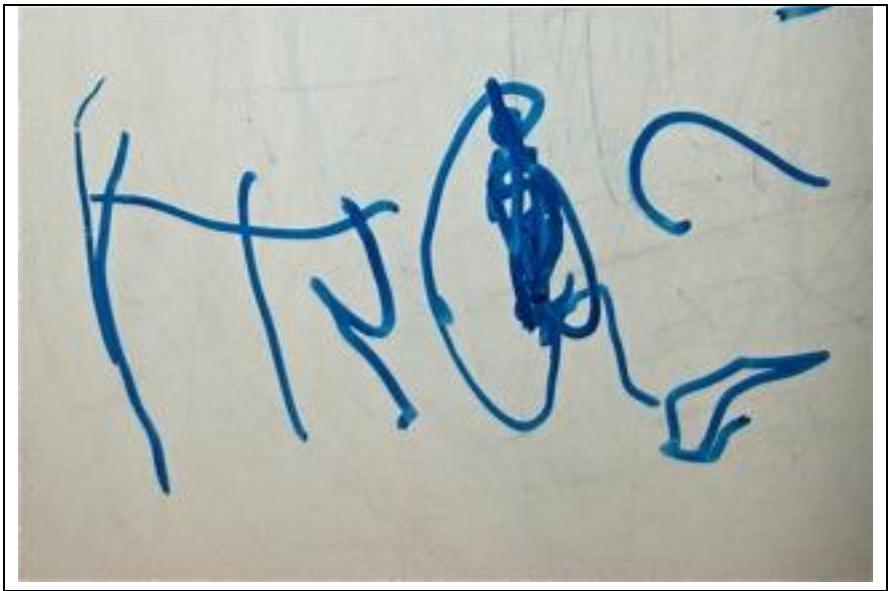

**Figure 5:** *Finn's fractions (b)*

**Keeping scores**

In their play area outside, some Reception children had chosen to take turns to throw a ball into net and count their goals. One child decided to keep a count of his scores on paper on a nearby easel, and wrote his name to show that he had scored one goal. Others joined in, representing their scores by writing the quantity they had, such as '3', '3', '4', '5' or '1' and some wrote tallies. Next Ellie wrote her name twice, to signify 'two goals scored'. Rakeem (5 years and 1 month) had his own ideas and drew a Christmas tree in a pot with a circle around it, to show the single goal he had just scored. Jody (4 years and 11 months), was intrigued by Rakeem's idea and when she scored 2 goals also drew a Christmas tree but this time, drew 2 pots beneath it as her personal sign for '2 goals'.

**Figure 6:** *Jody's sign: '2 goals'*

Having freedom to decide how they would represent their goals meant that the children chose ways that were most meaningful for them. They created signs to solve their own problems (i.e. representing their scores), using ways that made personal, mathematical sense. Rakeem's single Christmas tree became a peer model for Jody who adapted this sign in a novel way to represent '2 goals'. Soon their teacher joined the children and together they discussed the meanings of their various signs.

**Figure 7:** *Signifying ball-throwing scores using numerals and tallies*

These play episodes reveal the considerable potential of young children to explore their mathematical thinking, meanings and understanding through graphicacy. As one nursery teacher recently remarked, *'Children's mathematical graphics* has influenced everything we do - and also the way in which we view children's play'.

**Starting points to support *children's mathematical graphics***

- Provide an environment where papers and pens etc. are easily accessible
- Value *children's mathematical graphics*
- Observe closely and annotate *children's mathematical graphics*; this allows adults to sensitively uncover children's thinking and meanings
- Model *mathematical graphics* indirectly as it is important for children to see different ways to write down mathematical thinking.

- Discuss the *children's mathematical graphics* with a colleague or a group of interested teachers/practitioners. This will give you ideas and support your thinking. Join a local children's mathematics network group or start your own: http://www.childrens-mathematics.net/cmnetwork_groups.htm

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