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## **Communicating mathematically – ‘*necessary*’ for children in their play**

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### ***Introduction***

‘Learning through play’ is widely accepted in early childhood education in the west, but there is also increasing pressure for children to acquire academic ‘skills’, particularly in literacy and mathematics. The abstract symbolic language of mathematics has been shown to cause particular difficulties for children and for teachers there can be a tension between play and teaching early ‘written’ mathematics. Whilst colouring-in worksheets and tracing over numerals are without context or real meaning for children and are not recommended in the English curriculum, they are common practice for young children, and familiar in many countries around the world.

In contrast a cultural-historical approach empowers young children to draw on their home experiences and develop understandings in natural, authentic and meaningful ways in the context of their play (Vygotsky, 1978). Play also leads to changes that involve communicating mathematical thinking, especially important since mathematics ‘is really about problem solving with symbolic tools’ (van Oers, 2001).

Representing meanings with ‘symbolic [or cultural] tools’ such as gestures, actions and language is important aspect of Vygotsky’s work: symbolic tools also include objects such as Vygotsky’s example of a child using a stick when pretending to ride a horse. Children also freely make meanings through *graphics* (i.e. their own drawings, maps, writing and mathematical representations) which are also symbolic tools.

Grounded in Vygotsky’s work, Dutch Developmental Education views play as ‘pretend play’, whereas in the English early childhood curriculum ‘play’ includes children’s freely chosen ‘play’ activities such as pretend play; play with sand, water and building bricks; outside play; making models, cutting out and drawing.

### ***Research in England***

We have researched children’s mathematics for two decades, beginning by exploring children’s early ‘written’ maths from an ‘emergent writing’

perspective in the classes where we taught, and developing *children's mathematical graphics* (e.g. Carruthers and Worthington, 2006, 2011): though not the same both are 'semiotic' or *meaning-making* approaches and begin in play. Vygotsky recognised play as contributing to 'the highest level of pre-school development,' (1978: 102-103), arguing that 'each step' supports children's cognitive thinking that becomes 'more complex and richer' (Vygotsky, 1987: 349).

Analysing hundreds of examples we charted *children's mathematical graphics*, showing how their thinking really does become 'more complex and richer'. Children appear to develop deep understandings of the communicative purpose of symbols that supports their understanding of 'written' mathematics including number and quantities, and subsequently calculations, problem solving and data handling. Van Oers suggests that *children's mathematical graphics* point to joint meanings through interactions 'between children, their peers and adults', where 'mathematical meanings emerge' as tools which the children use to communicate within their play or activity (2009: 32). In the course of communicating through their *mathematical graphics*, the *processes* of mathematics such as representing and interpreting symbols, enquiring, reasoning, justifying and solving problems all come to the fore.

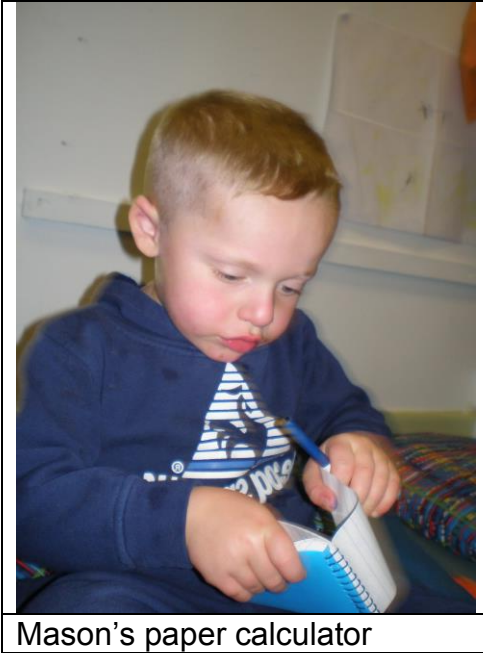
### ***Play, imagination and graphics***

Vygotsky wrote that '... writing should be meaningful for children, that an intrinsic need should be incorporated into a task that is *necessary and relevant for life... reading and writing should become necessary for her in her play*' (1978: 117/118, italics added) and it seems logical that 'written' mathematics should also be 'necessary' for children.

In my doctoral research I am focusing on the emergence of *children's mathematical graphics* in play and have many wonderful examples from 3-4 year old children in an inner-city nursery school in the southwest of England (including many of those included here). Such rich play experiences support children's own decisions, showing that communicating through graphics really is *necessary* for them *in their play*.

### **Paper calculators**

Mason was playing with a real calculator and pretending it was a digital game pressed the buttons saying, '*Fighting games! Video games!*' Then making marks on the page of a small notebook, he tore it out explaining, '*This is a different calculator - with computer games on*'.



Mason's paper calculator

Watching Mason, Alfie made some symbols saying '6, 7, 8, 9, *I've done a number 10*', followed by another page, '9, 10, 11, 12': in twenty minutes Alfie made a total of seven 'paper calculators'. Several other children joined in, developing their own paper calculators: referring to one he'd made Alfie announced "Lots of fighting!" A week later Mason explained he'd made a '*different* calculator with Batman' on it.

The children understood:

- The active (dynamic) role of pressing buttons, controlling and changing what they saw on the screen;
- The need for numerals on a calculator.
- Some children used rapid scribble marks to *indicate drawing*, writing or numerals.
- Alfie demonstrated his ability to count a consecutive series of numbers.

The boys' interest in technologies and popular characters influences their pretend play (Wohlwend, 2009; Worthington, 2010): in this instance they sustained their interest in 'paper calculators' for more than two terms.

### ***Children's mathematical graphics in pretend play***

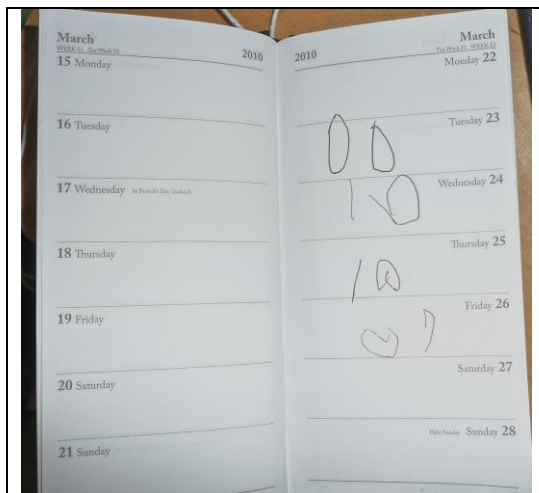
Grade 0 and 1 classes in Dutch 'Development Education' schools and the same age groups in England have similar areas and resources for pretend 'home' play and contexts such as 'shops' or 'hospitals'. However in our research in England we found that the richest and most complex play arises in children's *spontaneous* play, rather than in a specific pretend play area, planned and resourced by teachers.

The teachers involved in this research make many observations of the children's play, and reflect on these through joint discussion with colleagues,

helping them better understand the children's thinking. These teachers have been described as 'master' teachers and their pedagogy is highly effective in supporting children's play and thinking. A significant aspect of the teachers' role is to engage in collaborative dialogue with the children, mediating understanding about their graphical symbols and representations: this enables them to support the children's thinking and helps them negotiate and co-construct meanings.

The nursery teacher Emma set out musical keyboards for some children to play. Several telephones and old diaries had been left nearby and Emma was surprised when rather than playing the instruments, Isaac took a diary and announced he was *'taking bookings for the camp site'*. His friend Oliver immediately responded, and picking up a phone saying he'd like to stay for two nights.

Isaac replied *'No. I'll put you down for two million nights, but don't worry, it's only £1.00 a night'*. He then wrote made marks in his 'booking book' (the diary) and Oliver made his own symbols in another diary.



Oliver's symbols for the campsite booking

Isaac's experiences of camping with his family on many occasions supplied the cultural context and Oliver was able to join in this play: their graphics show that:

- Isaac knows it is advisable to ring and book a pitch at a campsite before going camping, and that bookings are written down.
- The scribble-marks Isaac made appear to be *indications* of writing, rather than early written letters.
- At this time Oliver often used a letter 'O' followed by a wavy line when writing his name and may have generalized about his use of this symbol.
- Offering to book *'two million nights'* reveals Isaac's sense of humour, and adding *'Don't worry – it's only £1.00 a night'* suggests that he knew that the real figure for one night's camping would be more than £1.00.

### **'Look! No chicken!'**

Shereen decided to play cafés and asked several friends, *'we make cake, you want cake?'* She fetched four bowls and sharing some playdough between them, took a cardboard box for an 'oven' and put her 'cakes' inside it. She noticed that one child had not joined in 'eating', and picking up the bowl looked into it, asking *'you not very hungry?'*

Next Shereen drew wavy lines on a notepad, asking her teacher *'I'm writing chocolate bar, what you want? I've got rice, chocolate, chicken?'* Emma replied that she'd have some rice, and pretending to prepare the rice, Shereen explained its price, *'There you go, it's 2, 1, 2'*. Shereen returned to see if Emma wanted anything else, *'what you want: rice, chocolate, cake and chicken?'* Emma said that she didn't want chicken and Shereen wrote some wavy lines for 'chicken' and putting a cross by it, said firmly *'It says 'x' – no chicken'*.

Later Emma said that she'd changed her mind and she would after all, like chicken. Looking at her notepad Shereen pointed to the 'x' she had written and explained firmly *'Look! No chicken!'* then drawing a mushroom asked *'You want mushroom?'* and Emma agreed. Shereen explained further, *'Look. A tick, that mean we got some'*, then added, *'you want ice cream? It's 3, 4'*.



*'Look! No chicken! You want mushroom?... Look. A tick, that mean we got some.'*

The next day Shereen continued playing cafés outside, once again taking orders for food.

This lovely example highlights what is described as 'funds of knowledge' where children draw on their cultural knowledge and experiences of home in their play (Riojas-Cortez, 2001). Shopping, preparing food and sharing food at home and eating out are all activities in which Shereen is involved. This was emphasized for me when, during the course of my research I made a home

visit to Shereen and was handed a plate of noodles by her grandma soon after I'd arrived! Shereen's use of symbols here showed she understood that:

- Waiters offer customers a range of choices from the menu.
- They write customers' orders, checking if there is any dispute.
- Waiters provide the various prices, using a range of symbols to do this.
- A tick can be used to mean 'yes' and (in this context) a cross can mean 'no'.

This play narrative also shows how rich periods of *sustained* play can be: this means that children sometimes choose to sustain their play narrative for a long period on one day, and in other instances they repeatedly return to their play over an extended period of time.

### ***Early childhood cultures***

These examples show how *necessary* communicating mathematical meanings were to the children within their play, and reveal the complexity of young children's thinking with graphical symbols. When the classroom culture supports such rich play where teachers value, understand and support children's graphical representations, children frequently and freely use graphical marks and symbols to communicate their mathematical meanings and adapt, co-construct and negotiate symbolic meanings so that they evolve over time.

However, although other teachers and schools throughout England and elsewhere have begun to explore *children's mathematical graphics*, the rich examples included here are not yet common practice. Perhaps above all it is teachers' views of children as learners that most influences what happens in classroom. Seeing young children 'as competent individuals who are capable of making meaning, in collaboration with others and with the support of cultural tools', (Brooker, 2010: 44) leads to children who believe themselves able to communicate mathematically, able to develop deep understandings of the abstract symbolic language of mathematics.

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See also: [www.childrens-mathematics.net](http://www.childrens-mathematics.net)

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