Nursery World Show | Saturday 6th February 2016

Presented by | Dr Lala Manners

Topic | 'Meaningful Maths : Learning through Physical Play'

Introduction

From conception to life in utero and beyond – we experience mathematical concepts and use mathematical reasoning on a daily basis – in a wide range of environments, occupations, opportunities and challenges.

For the growing foetus life is about developing an understanding of space and perimeter, orientation, dimension, gravity - becoming aware of varying rhythms and sounds – both external and internal – and learning to accommodate, adapt and react to a confined environment.

At birth – bodies must suddenly absorb a range of changing physical circumstance – different spaces (cots/buggies/high chairs/blankets) – different elements (water, clothes) – different people who handle differently (movement dynamics) – changes in the weather – and night and day.

As young children develop – and acquire/rehearse/refine their physical skills – the world becomes ever wider and more interesting – rolling, crawling, walking and running are mastered – all of which require a growing awareness – and use of mathematical concepts : forces, levers, direction, distance, area, speed, symmetry, pattern, rhythm. With an increasing emphasis on manipulative skills – children begin to imprint on 'things' what their bodies have learned already – they learn to 'balance in space' as they also 'balance space.'

As adults we experience and use (often quite unconsciously) a vast range of mathematical concepts and skills all the time : we take even steps as we walk – avoiding bumping into others……we drive and ride bicycles with hands precisely placed – using powers of estimating/anticipating/balance to keep safe……we make beds with even sides …….we place biscuits with precision on a baking tray…..we put exactly the right amount of coffee and water in a cup…….we know exactly how much water to put in a bath…….how to pack a suitcase …….lay a table…..stack shelves…….the list is endless!

So why – if we seem to manage our lives quite adequately does this country remain so woefully poor at maths? Twenty- eight per cent of young children failed to achieve an 'expected' level of numeracy in 2013/4 – we continue to appear low on the International PISA tests – and getting all children to gain a good maths GCSE is a perennial problem. Two million children are said to suffer from 'maths

anxiety' and universities report having to deliver 'remedial maths' courses to physics and engineering students.

What is going wrong?

Children arrive at nursery with a wealth of mathematical awareness and experience……what are we doing that effects such a calamitous situation further down the line……and what can we do to turn this around? To find some answers – we need to back to the beginning…….

Back to the (very) beginning!

For the ancient Greeks 'knowledge' was divided into two very clear bodies – gnosis and episteme. Gnosis encompassed knowledge that relates to meaning and wisdom – that came through study of myth, metaphor, fable and allegory – it had purpose and was a lifelong process of positive engagement with the world. Episteme was more skill based – what was needed to be known at certain points in life – not explicitly 'taught' or considered overly important.

Pythagoras was the first thinker to convert practical 'know-how' (episteme) into a body of theoretical knowledge that had intrinsic value. With Plato came the beginnings of what we would recognise as 'formal education.' Knowledge became separated into discrete 'disciplines' – although at this point – mathematic was considered as supporting all areas of learning – and not as something 'apart.' Euclid was the first to use the discipline of 'logic' to prove geometric truths – developing a system of learning still evident today – moving in a linear, incremental fashion from 'self-evident fundamentals' to more sophisticated insights.

Throughout the medieval period the emphasis was on geometry/astronomy – and arithmetic/music. Astronomy played a critical role in navigation and surveying – many specialists were also engineers and physicists. Mathematical thinking had a vast remit – it informed, supported and underpinned the understanding of LIFE.

The **first** issue that really impacts on our mathematical provision goes back to the 17th Century 'Rationalist' movement – particularly the work of Rene Descartes. His bringing together through a 'co ordinate system' the worlds of geometry and arithmetic was revolutionary – but what concerns us most is his absolute rejection of 'the body' as playing any meaningful role in any area of learning. For Descartes – the highest form of human endeavour was to 'do science' – then refine this by 'doing mathematics' (the plural form is his invention) – only then would 'body transcending rationality' – be achieved. The physical body (the Material) was considered merely a 'box for the brain' – a conduit utterly inferior to the brain (the Ideal). This thinking has cast a very long shadow over educational provision generally ever since.

The **second** issue that affects us directly is the legacy of the Industrial Revolution in the 18th Century - specifically the emergence of state funded schools that were created to cater for a growing workforce. Only the most useful and beneficial skills were taught – considered to be arithmetic and basic algebra - although some geometry (only that which could be easily

tested) was included. Maths was basically 'working out a sum' - there simply wasn't the time, motivation or interest to widen the remit – children had to leave school with just enough basic knowledge in place to ensure the wheels of industry were served without difficulty.

From this period onward the mathematics curriculum has been narrow in focus and (following the Euclidean model) structured in a linear, incremental fashion. It has also completely jettisoned the Platonic focus on knowledge as related to life. Add in the Cartesian insistence on the superiority of mind over body……

What have we lost along the way? Considering the main area of job growth lies in computer graphics, engineering and medical imagery – are we really giving children the skills needed? The interfaces to access information are shifting quickly from the alphanumeric to the spatial - quantatitive (arithmetic/computation) and qualitative (geometric/spatial) domains are merging to form new areas of knowledge.

How may we best support children's mathematical thinking – preparation for LIFE?

1. Place physical experience at the centre of mathematical provision – HOW they learn

The work of Merleau-Ponty has been important in redressing the damage done by Cartesian 'dualism.' For him – the physical body must play a central role in learning – it is 'the site and means of knowing.' Sensory Perception is therefore not a 'channel that separates' but a 'membrane that connects.' Knowing something is not just a matter of thought – it requires doing and feeling also – the body is – above all – a 'knowing system.'

The 'enactive' movement has also been important in placing the body at the centre of mathematical learning – mathematical understandings rooted in the 'biological body' cannot be considered apart from the 'epistemic' body of mathematical knowledge from which these understandings arise……..mathematical knowledge must be 'embedded' in lives – there are no sharp boundaries between bodies of knowledge and physical bodies – 'they are ultimately indistinguishable aspects of the same whole.'

We advocate a 'ROLLING MATHS' approach – that supports 'rhizomatous learning'…..learning that (unlike Euclid/ Industrial revolution) is not always linear and nicely parcelled into small easily testable units – that may not have an identifiable beginning and end. Learning can be unpredictable – and sometimes chaotic – so is life.

2. Focus on SPATIAL REASONING – WHAT they learn

Spatial reasoning is a new research field – and one that is becoming increasingly important as the gap between mathematical knowledge and the skills demanded by an ever evolving workplace grows wider and more critical – particularly in the STEM professions (science, technology, engineering, mathematics).

Three 'powers' are involved in working with space : Tahta (1989) – (spatial reasoning was not a phrase used at this point) – but these 'powers' provide a useful means to focus on the interplay of practices.

- Imagining (seeing what is said)
- Construing (seeing what is drawn – saying what is seen)
- Figuring (drawing what is seen)

This has been expanded by the Spatial Reasoning Study Group (SRSG) since 2012 to include the following 'dynamic processes.'

- Locating
- Orienting
- Decomposing/recomposing
- Shifting dimensions
- Balancing
- Diagramming
- Symmetrizing
- Navigating
- Transforming
- Comparing
- Scaling
- Sensing
- Visualising

Why is spatial reasoning so important for young children?

Children's spatial skills at 3 yrs are a strong predictor of mathematical performance aged 5 yrs – and are considered a much better predictor of future school performance than language or maths itself. Complexity of block building at 5 yrs is also considered of importance in predicting future academic success.

Comparing EY mathematical experience between England and Eastern European countries (where maths is a high status subject until 19 yrs) – it is clear that the delaying of writing maths (and absence of IT/ worksheets) has a beneficial impact on engagement and success in the subject. Absence of (written) evidence of learning is not considered evidence of absence (of understanding) – something we should definitely appreciate.

Maths is an inherently spatial subject – and we should do all we can to support 'bi-numeracy' – that is – bridge the gap between the world of children's own mathematical experiences which are evidently rich and varied – and the world of formal techniques that will help support life-skills in the future.

How may the SIX principles of a movement approach to learning support 'spatial reasoning'?

- **Start where children are**

Understand, appreciate – and VALUE the wealth of experiential mathematical knowledge and spatial reasoning that children acquire through daily life – give them a wide range of opportunities – and plenty of time to work individually and with others to explore and develop their skills – particularly building/paper folding/puzzles/drawing

- **Use of Immediate Environment**

The 'Immediate Environment' in movement terms is a) the individual/physical body b) the group c) the physical environment. Use children's bodies as the primary means by which mathematical concepts are introduced/realised/used – early 'spatial awareness' must be harnessed to support 'spatial reasoning' – HOW to use knowledge gained – how it links to other areas of learning – why it is important – EMBED new knowledge in relevant/meaningful experience – make connections

- **Hand Apparatus**

Must be easily accessible/free – known to children – not sports oriented or commercial. – enough available for all : Paper bags/cups/plates – magazines – egg boxes – dish cloths – bedspreads/sheets – socks/tights – milk bottle tops/plastic lids……

- **Music and rhythm**

'Steady Beat' competence important – another good predictor of future school performance. Develop : anticipation/memory/mirroring/patterning/timing/sequencing. Can use number rhymes and songs – try not to rely on commercial materials

- **Group work**

Important element in developing spatial reasoning – collaboration/problem solving/delegating/decision making – discussion : (how/why/if/when/perhaps/probable/possible)

Games : connect 4/drafts/dice/cards/board games

- **Transfer of skills**

Understand, appreciate and value the place of spatial reasoning in children's lives – how the provision for this can affect their future confidence in maths generally. Encourage parents to repeat activities so children feel that maths skills have some relevance/meaning/use. Number awareness is important – but it should not be the primary focus – the flow between mind and body should be validated at this stage through continual 'embedded' provision for mathematical thinking

Conclusion

Physical Development is a 'Prime Area' of the EYFSC for a very good reason. As an 'experience expectant' area of learning it supports, informs and underpins the 'experience dependent'/ Specific area of mathematics.

We must find new and creative ways of bringing the two closer together – placing the body centre stage as a critical conduit by which learning and understanding is assured.

We need to ensure young children have the confidence and competence to use mathematical concepts freely and imaginatively – without having to prove anything on paper – or to continually repeat 'numbers' for no good reason.

Spatial reasoning is a very new research field that is changing and evolving all the time – although it is looking back to an area of knowledge that played a central role in learning until the mid 19th Century. We need to build on the mathematical knowledge children bring with them to our settings – and be far more aware of what they are taking away and how it may be used most effectively.

'Mathematics has beauty and romance – it's not a boring place to be the mathematical world – it's an extraordinary place – it's worth spending time there.'

Prof. Marcus du Sautoy – University of Oxford

A puzzle to finish – what is the difference between :

- They came inside
- They went inside

A lot of spatial reasoning skills are needed to explain!

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