W1 Intro//Children's development

1A: Introduction to the unit

Overview

- Unit aims and materials
- Structure of the unit
- Learning activities
- Mathematics teaching in schools
    - Should learn alternative methods to teaching than how it was taught to us
- Your learning goals for this unit

Aims of this unit

Questions

- What is mathematics
- How do we learn mathematics
- How does teaching affect learning?
    - Theories of teaching

Goal

- Begin to develop a personal philosophy of mathematics learning and teaching that is informed by research findings

Method

- Critical reflection

Mathematics teaching in schools

Hiebert (1986)

- An almost exclusive focus on procedural efficiency at the expense of conceptual understanding
    - Focus on getting the answer right as opposed to understanding

Stacey (2003)

- Shallow teaching syndrome: "…the low complexity of problems undertaken with excessive repetition, and an absence of mathematical reasoning in classroom discourse"
    - Drill and practice

TIMSS Video Study (87 Yr8 Teachers from different schools)

- "Opportunities for students to appreciate connections between mathematical ideas and to understand the mathematics behind the problems they are working on are rare." (Hollingsworth, Lokan & McCrae, 2003, p.xxi)
- Students feel that mathematics is inaccessible, related to ability rather than effort, abstract and value free (Ernest, 2010)
    - Lack of conceptual understanding conveyed through teaching
    - If they get the answer right, does that mean they understand it?
    - Mathematics is perhaps not as black and white as students think
        - There is room for opinion

1B: Understanding children's development of mathematical concepts

Overview of Lectorial Bs

Applications of theory and research in practice

- Children's development of mathematics concepts
- The impact of technological tools on learning

- Promoting meaningful early numeracy
- Addition and subtraction concepts and processes
- Multiplication and division concepts and processes
- Fractions
- Pattern and structure
- Measurement
- Spatial and geometric understanding
- Statistical reasoning and data exploration
- Chance and probability

Overview

- Mathematical development: key processes
- Pre-schoolers' mathematics development (video)
- Key research findings
- Views of mathematics learning
- How children learn mathematics
- Implications and summary

Early mathematical development: More than just counting

- New research, development and cognitive, indicates mathematical concepts can develop before verbal counting
    - Learning to count is fundamental and innate but there's a lot more than a verbal count
    - Related to interpreting the 3D world
    - Rote learning may be necessary
- Spatial reasoning is central to innate mathematical development, not quantity
- Noticing patterns and relationships is key to successful mathematical thinking

Mathematical development

- Intuitive notions - observing, visualising the 3D world
- Noticing patterns
    - Sequence of eating and sleeping
- Embodied action (with language) - dynamic movement in collaboration with the real world e.g. baby getting into a pool and feeling the water rise (displacement)
- Modelling - imitating, imprinting
- Representation (child-initiated) (more next week) - makes some attempt to replicate some idea/thought/movement e.g. haptic technology e.g. iPad
- Developing relationships (structural relations) - connections
- Communicating: symbolic recording (child initiated)

Kid climbing play-ladder

- Structural representation of equal sized rectangles on a vertical plane
- Equal amount of space to climb each time
- Some children may notice the pattern, consciously or not - we are not sure

Key research findings

- Children learn at different rates and in different ways
- Development moves from informal notions to concrete/symbolic, abstract and generalised ideas
- Mathematical concepts can develop simultaneously or out of order
    - Children can learn to subtract before add, contradicting previous thoughts
- Children who do not develop abstract ideas do not see underlying pattern and structure

    - Struggle with algebra
- Children learn when they are challenged to think beyond existing concepts
    - Key to know what level the children are at

Views of mathematics learning

- Children acquire concepts through action (embodiment)
- Children construct and develop their own ways of doing mathematics (constructivist)
- New concepts and understandings are linked to a child's existing knowledge base (scaffolded) (Vygotsky)
- Mathematics learning can be abstract and generalised earlier than traditionally believed
- Learning as a social activity (social-constructivist)
- Cognitive neuroscience approaches
    - Multi-disciplinary approach

Perceptuo-motor activity and imagination (Embodiment)

- Relationship between body activity and mathematical understanding
- Young children's mathematics developed through dynamic/kinaesthetic action (Nemirovsky & Borba, 2003)

Social-constructivist perspectives

- Socially constructed meaning developed through negotiation and consensus within the community of learners
    - Learning is negotiating between members of the group
- The impact of the learning environment and the role of teacher pedagogical knowledge impacts on mathematical development
    - Teacher needs to know how to engage in making sure the students are actually learning what their intent is

How can we promote mathematical thinking?

- Provide experiences that challenge children's mathematical thinking and problem solving
    - Being good at forming challenging questions
- Assist children in seeing the underlying structure of different mathematical situations
- Provide a range of experiences in which children explore various patters in numerical and spatial situations
- Provide activities that require children to interpret, describe, explain, question, analyse, critique, debate, justify, and predict
    - Lots of numbers but not enough geometry in activities

Conceptual understanding

- Conceptual understanding is built on making links between representations of mathematical ideas
    - Usually comes from modelling/representation
- Children's mathematical links, or lack thereof, can be observed through verbal and written explanations, modelling, and pictorial, iconic and notational recordings
    - Children need something to touch, sort and feel

Recording subitising dot patterns

- Subitise - immediately calculating/counting without counting one by one
- 3 different levels in the students pictured

Representing and explaining number relationships

- Student drew a rainbow
- "I can see a pattern. Numbers go up but they have pairs. You join them like a rainbow. 5 is in the middle so it is 5 up or down. You can add them forwards or backwards. It's the same either way"
- Kindergarten student
- What is the role of imagery and pattern here?
- Did they mum or teacher teach the rainbow? Probably not

Concept development through children's imagery

- Images created were either static or dynamic in nature (Thomas, Mulligan & Goldin, 2002)
- Dynamic imagery linked to high achievement
- Imagery influenced creation of mathematical concepts e.g. "My dad's truck goes 100"

Learning mathematics through children's picture books

- Language of mathematics (e.g. positional language)
- The role of pictures/imagery to embody mathematical ideas
- Predictive reasoning (i.e. what will happen next?)
- Spatio-temporal concepts (e.g. how much longer will it take?)
- Literacy and counting
- Number and pattern
- Pattern and geometry
- Scale and comparison

What are the challenges?

- Early mathematical development is a predictor of later achievement
- Too many children do not develop an early understanding and awareness of patterns and relationships
- Young children need fundamental mathematical foundations for the future, which traditional curricula do not provide
- Mathematics in the real world increasingly calls upon complex problem solving involving a range of interdisciplinary and technological skills and processes
- e.g. Too much going on at home could mean children do not learn what is important in mathematics

Implications and summary

- Recognise and interpret children's informal mathematical knowledge
- Assist children to build upon and represent existing knowledge structures (scaffolding)
- Recognise the differences in the way children experience and represent mathematics
- Identify development, or lack thereof, of conceptual understanding