

Numeracy Difficulties

A Developmental Understanding – Taryn Moir

INTRODUCTION

Arithmetical development in children is non-linear and multidimensional. Young children draw together threads of quantitative experience and link these with growing verbal number strings as they slowly construct a rich understanding of number. This complexity of mathematical understanding contrasts starkly with the layout of many guides for teachers. One should not assume that because a child has difficulty with one aspect of number learning, other areas will be problematic. It is argued that programs need to include all number domains in tandem (addition, subtraction, multiplication, and division) as children's construction of number knowledge in a specific domain is not dependent on prerequisite knowledge in another domain, but dependent on being able to take advantage of a range of experiences within that domain.

The traditional UK number curriculum moves rapidly into number operations in the first year it is developmentally inappropriate for a significant proportion of children in the first year of schooling. Ridler-Williams found that a large proportion of Scottish school children had not progressed to the Initial Number Sequence by the end of their first year at school and were therefore not truly comprehending the number operations they had been taught. Children whose number development is not well synchronised with classroom demands can develop a range of beliefs that number lessons are beyond their ability and that they are a series of guessing games or rote learned procedures.

FIVE BROAD STAGES IN UNDERSTANDING MATHEMATICAL OPERATIONS:

In this progression, movement from one stage to the next involves cognitive restructuring rather than a slow accretion of knowledge.

Stage 1: Emergent Number Stage: at this stage, children are just beginning to construct the counting sequence and are still developing one to one correspondence.

Stage 2: Perceptual Number Stage: At this stage, children can only deal with adding together quantities that are visible. In the classroom they look as though they understand early math operations, because they can work with visible quantities.

Stage 3: Figurative Number Stage: At this stage children seem to be able to deal with screened addition, but they are using a 'number sequence' logic to achieve this. They can not yet operate with cardinal numbers. In the classroom they look as though they understand early math's operations because they can use cardinal strategies to work with hidden quantities

Stage 4: Initial Number Stage: At this stage children have acquired an adult like understanding of number and are able to comprehend number symbols and operations such as addition and subtraction. Children need to reach this cognitive stage before they can grasp the elements of the formal number curriculum - cardinal number, written number symbols and number operations.

Stage 5: Facile Number Stage: At this stage children are developing higher-order number concepts and become able to focus on the relation between operations. Children need to reach this stage before they can grasp elements of the more advanced primary curriculum such as fractions, ratio, and percentages.

It takes children several years to grow from the Emergent to the Facile stage. Until children have reached the Initial Number Stage, they cannot grasp the mathematical nature of operations such as addition or subtraction and the formal written curriculum is lost on them. There is much variability in the length of time that children take to reach this stage.

ASSESSMENT OF MATHS AND NUMERACY SKILLS

- Understanding of basic concepts of size and sets (at perceptual and symbolic levels)
- Knowledge of the number system and counting skills
- Understanding of the language of maths
- Memory for specific number facts such as times tables and number bonds
- Computation strategies and procedures
- Attitude to learning maths and self-perception as a learner of maths.
- Ability to solve problems using mathematical concepts and numbers in everyday life.

On a practical level, children's errors in the number word are never accidental, and can extend the practitioner's understanding of the individual path that a particular child with difficulties is treading.

WHAT ARE THE SKILLS NEEDED TO GUIDE THE ACQUISITION OF VERBAL COUNTING SKILLS?

- Stable order principle Need to know the number names in the correct order.
- One to one correspondence- (about 2 years old) Need to link number names to one and only one object. No word to be used more than once and every object counted. Each object needs one to one, correspondence with the number names. (Often use their fingers)
- Cardinal number-The knowledge that the last number name counted gives the size of the set of objects.
- Order irrelevance principle -The child has to learn that the order of enumeration (from left to write or right to left) is irrelevant.
- Abstractness there is no constraints on the kinds of things that can be members of a collection, provided they can be individuated.

DEVELOPMENTAL SEQUENCE FOR COUNTING

- Counting all – counting for example 3 and 5. Will count 1,2,3 and then 1,2,3,4,5 e.g. Using fingers. They will then count them all together.
- Counting on from first number – not necessary to count from the first number (1) but perhaps start from 3 and then count 4 5 6.
- Counting on from largest number. More efficient strategy starting to add from the largest number e.g., 7 then 8,9,10.
- Memorised facts Likely that these are memorised from stage 3.

MISTAKES LEARNERS MAKE WITH NUMBERS

- Arithmetic facts
- Procedures/strategies/rules of manipulation
 - Translation –informal real life to formal
 - Translation – application of formal to real life
- Conceptual errors in measurement, shape & pattern
- Counting:
 - Errors with 1:1 correspondence
 - Increase in errors as size of set increases.
 - More errors if set presented randomly.
- Word problems
 - Understand the problem.
 - Translate to a maths representation.
 - Apply maths procedure.
- Numeracy

Classification - No Classification

As a result of learning experiences and outcomes in mathematics being more relevant to real-life learning contexts, children from P5 to P7 are carrying out the majority of their mathematics lessons through activities which make links across the curriculum where appropriate. The main aim of teaching mathematics in this way is to ensure that children enjoy exploring, investigating, and applying mathematical concepts to understand and solve problems. There is an emphasis on collaborative learning to encourage children to reason logically and creatively through discussion. When children learn about the properties of three-dimensional objects, they link it to their topic work, where they learn about churches on the Isle of Lewis. Children work in groups to plan and design a three-dimensional church. During this design and make process, they use their knowledge to build nets, measure accurately and identify faces, edges, vertices, and angles. This type of task results in children being actively engaged and their understanding being enhanced. Groups present their findings to their peers, including delivering a presentation. In their evaluations, children commented on how much this approach to learning has impacted on their learning and enjoyment of the topic.

KEY RESEARCH

- Engagement and meaningful activities are important (Baker, 2005)
- “Bad practice” is applying procedures without understanding (Swain, 2005)
- High levels of effective questioning, collaboration and engagement were found to be effective (Swain & Swan, 2007)
- Low and middle achievers quickly resigned themselves to failure without attempting tasks they had been set (Ashby, 2009)
- Carraher (1985) found that children who struggle with written representations of problems should.
 - not be rushed.
 - Are not ready to write down problems and solutions until they can express them orally.
 - Symbols shouldn't be introduced until they have been represented orally and pictorially.

THEORY OF CONSTRUCTIVISM

When you teach a child something you take away forever his change of discovering it for himself”

“Play is the answer to how anything new comes about”.

“Children have real understanding only of that which they invent themselves”.

“What a child can do to today with assistance he will be able to do by himself tomorrow”.

“By giving students practice in talking with each other, we can give them the frames for thinking on their own”.

“The teacher must adopt the role of the facilitator not the content provider”.

CHARACTERISTICS OF GOOD NUMERACY INSTRUCTION

- Caring ethos
- Mix of whole class and group discussion
- Assessment is for learning.
- Students taught how to articulate explanations and justify solutions.
- Focus on thinking that leads to a solution rather than on procedural roles to get the answer.
- Effective teacher questioning to understand pupil thinking and reasoning.
- Worthwhile tasks- relevant, meaningful, challenge

International research overwhelmingly promotes a move away from traditional emphasis on learning rules for manipulating symbols to focus on practice that promotes active engagement.

Pupils should not be taught conventional written algorithms until they are able to add and subtract mentally two-digit numbers.

INTERVENTIONS TO ENHANCE NUMERACY SKILLS

Classification - No Classification

- Children with serious difficulties should have one: one intensive interventions with a teacher or in some instances a small group might be appropriate.
- Less severe difficulties may require fewer intensive interventions which may be delivered by teaching assistants and could be delivered in a small group.
- Core instruction should include:
 - Systematic and explicit instruction
 - Use of visual representations
- Supplementary instruction should include:
 - Increased level of targeted instruction in addition to core instruction
 - Instruction in small group setting or individually.
- Evidence based interventions should be introduced as early as possible.

CONCRETE TOOLS

Real things and structured images enable children to understand the abstract.

The concrete and the images are a means for children to understand the symbolic so it's important to move between all modes to allow children to make connections.

Morgan, D. (2016)

Used well, manipulatives can enable pupils to inquire themselves- becoming independent learners and thinkers. They can also provide a common language with which to communicate cognitive models for abstract ideas.'

Drury, H. (2015)

Jean Piaget's (1951) work suggests that children aged seven to ten years old work in primarily concrete ways and that the abstract notions of mathematics may only be accessible to them through embodiment in practical resources.

[Ofsted's 2012 report 'Made to Measure'](#) suggests that although manipulatives are used in some primary schools to support teaching and learning they are not used as effectively or as widely as they might be.

- Concrete objects give children a deep understanding of math.
- Concrete resources give time pupils to investigate a concept first - and then make connections when formal methods are introduced.
- The pictorial stage allows pupils to demonstrate and sustain their understanding of mathematical concepts and processes.
- The abstract stage should run alongside the concrete - pictorial stage (enables pupils to read mathematical statements and show their understanding using concrete resources or pictorial representations).