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PYP Mathematics Scope and Sequence and the Numicon approach

Underlying Pedagogy

The International Baccalaureate Primary Years Programme (PYP) curriculum model is based on a belief that children develop and show their learning best when using a guided inquiry constructivist approach.

This is when learning is built upon prior experiences, models, and constructs, that are constantly revisited and revised as students are exposed to new experiences and learning. "We travel continually on the cyclic path of constructing, testing, and confirming or revising our personal models of how the world works (International Baccalaureate Organization)." To do this, new experiences are structured by the teacher to develop and promote a sound understanding of larger concepts, which can be visualized, communicated, linked, and generalized, to other ideas. This will in turn form a deeper more confident overall understanding.

In relation to mathematics, The PYP Mathematics Scope and Sequence suggests that **mathematics should be taught in a way that allows students to see mathematics as a way of thinking which they can explore in a real world and holistic manner** (International Baccalaureate Organization). This is in contrast to learning instrumentally (RR Skemp) through a series of facts and equations.

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Figure 1 from the PYP Mathematics Scope and Sequence illustrates the three essential stages needed for a student to develop their own conceptual understanding. It relates directly to Bruner's Concrete Pictorial Abstract approach (CPA) that stipulates **that in making learning meaningful, a child needs to first explore the idea using concrete materials, before developing a visual representation of the idea**. Once the concept is understood, the child can synthesize and use these ideas to an abstract or symbolic form (Bruner).

Constructing meaning

Transferring meaning

Applying with understanding
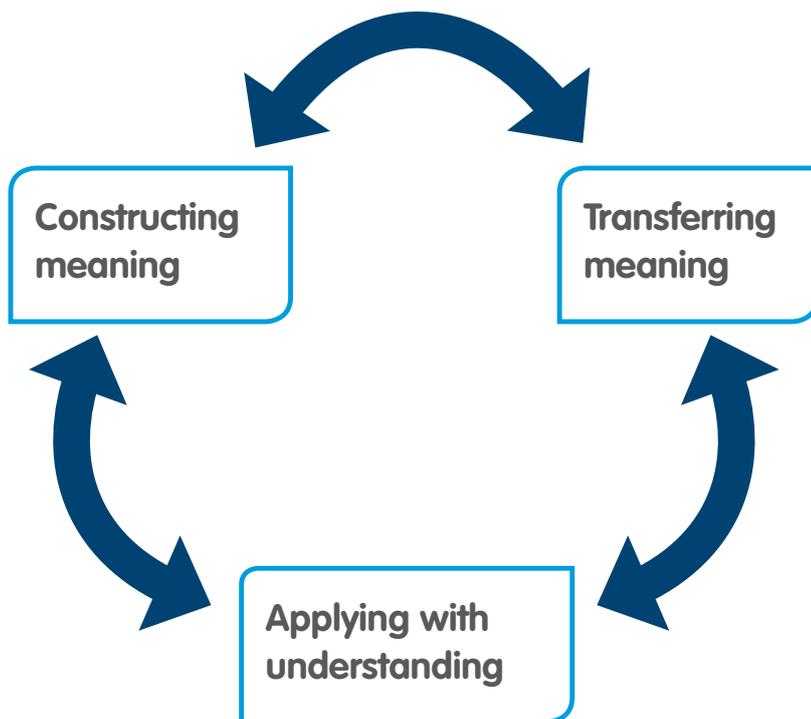
Figure 1: How children learn mathematics from the PYP Scope and Sequence

Constructing meaning: An active learning process where children experience new situations, ideas, and build their own prior understandings to create new meaning which can be presented with materials (concrete), diagrams (imagery), words and symbols (abstract).

Applying understanding: A child is then "acting on their understanding through authentic activities" (International Baccalaureate Organization). Children can analyse a problem, derive appropriate generalizations, and apply these in novel situations. This application of understanding could use concrete or visual models as well as abstract notation and sometimes all three concurrently to illustrate the underlying number patterns and relationships.

Transferring meaning: Once students have constructed and proved their ideas in authentic situations, they can then reflect, describe, and justify their understanding. This includes "converting learning into conventional mathematical notation" (abstract) (International Baccalaureate Organization), as well as proving ideas with written or oral explanations, and with visual and concrete models.

The essential difference between Bruner's initial seminal work and the PYP's adaptation of it, is that the PYP believes that learning is not hierarchical. At each of the three stages of learning there is interplay and interrelationships being developed using all parts of the CPA. This creates a constantly evolving, learning process that is unique to each learner.

Numicon is a flexible approach to learning and teaching mathematics which combines a set of resources and guides in a way that embraces the constructivist philosophy outlined earlier and in particular the CPA approach described by Bruner.

Numicon also emphasizes a circle of learning, shown in Figure 2. Direct comparisons and connections can be made to the PYP circle, and the CPA model.

Communicating mathematically

- Being active
- Illustrating
- Talking

Exploring relationships

Generalizing
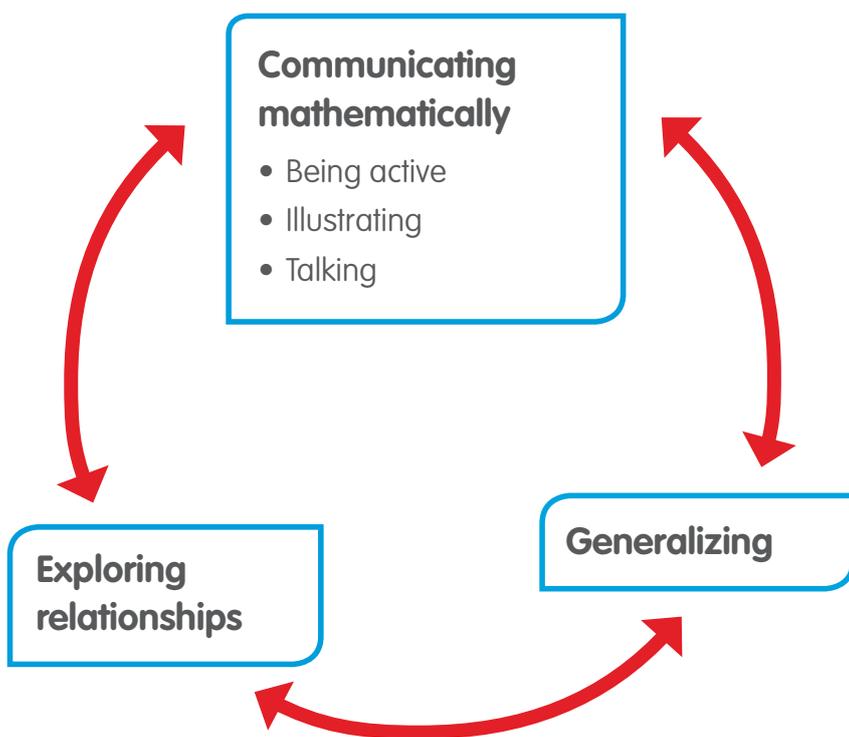
Figure 2: Numicon Circle of Learning

Communicating mathematically corresponds to *constructing meaning* in the PYP through action, imagery and conversation. The *'Numicon Implementation Guide'* suggests this aspect is about being active, physically fitting objects together, and a child showing their developing ideas with the provided learning experience, activity or objects. For example children can use spatial experiences to develop ideas such as bigger, more than, and share these understandings with their peers (Atkinson, Tacon, & Wing).

Exploring relationships is about developing control, illustrating understandings that the students have developed about the targeted mathematical relationship and reflecting on their thinking.

This aspect directly links to the *applying with understanding* stage of the PYP, and can also use concrete, visual or abstract models, in isolation or concurrently.

Generalizing involves abstraction, and the move to the use of mathematical symbols. For example three pencils and five pencils make eight pencils, becomes $3 + 5 = 8$. As the children generalize, they realize that the physical objects involved could be anything and not just pencils. Generalizing refers to the *transferring meaning* stage of learning in the PYP with the students illustrating the abstract concept of number with clear explanations and notations.

Both *Numicon* and the PYP programme are derived from the same fundamental philosophy. They are both constructivist, and emphasize the need to explore with materials to make necessary and salient conceptual connections. The similarities go deeper with *Numicon* and the PYP Scope and Sequence emphasizing a problem solving approach to mathematics. It recognizes that mathematical fluency is not about calculation, but involves a generalized conceptual understanding as well, which can be applied to novel situations (Atkinson et al.; International Baccalaureate Organization). Because of this, it is possible to pick out any *Numicon* Teaching Resource Handbook lesson suggestion, and link it to the PYP's underlying philosophy, as well as specific categories of the PYP Scope and Sequence learning continuum.

Ask your educational consultant for a copy of the *Numicon* to PYP curriculum mapping guide.
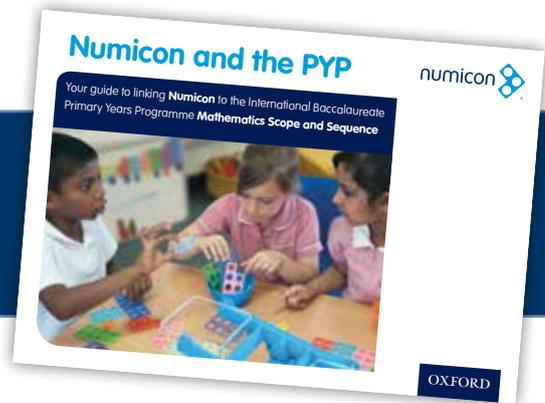
This report was written by David Lyttle (M.A., M.Ed., Dipl. Ed.) He is the Specialist Learning Support Teacher in Elementary School Mathematics at the 'IB world school' the International School of Düsseldorf (ISD). He is also a *Numicon* Affiliated Trainer.

David has a strong interest and deep pedagogical knowledge in mathematical difficulties, prevention and intervention, as well as ways to support gifted and talented students.

He has developed a successful customised mathematics intervention programme using *Numicon* that caters for students from Grades 1 to 7. He has been instrumental in the training and utilization of *Numicon* at ISD as a classroom resource and as an enrichment tool.

David became a certified *Numicon* Affiliated Trainer in August 2015 and has extensive experience teaching staff, modelling, observing, assessing, and assisting teachers both at ISD and beyond. He continues to lead regular successful *Numicon* CPD workshops at ISD, as well as providing inset training to other International Schools in Europe. He appreciates the overall versatility and utility of *Numicon* to complement any mathematics programme at all levels. He values how *Numicon* helps make the underlying patterns in numbers real.

For more information on *Numicon* Professional Development available near you, please email training.international@oup.com

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