

## **Reflection on milestones in pre-school mathematics**

*This rough draft is only meant to collect some reflections, to be discussed with educators and with didacticians that are specialized in pre-school mathematics.*

### **Comparison with reading**

Most children learn to read sooner or later. On the one hand, a child that is not presented with letters will not learn how to read. On the other hand, the best educator with the best material cannot make a child read “ahead of time”. Namely, each child seems to have their own moment when the brain is able to read groups of letters rather than just the letters one by one.

Nevertheless, to facilitate the child, all kind of games with letters are introduced, and educators give the good example by reading. What happens is that there is a kind of unpredictable milestone: one is encouraged to do all activities that point in that direction, and one ends up doing all kind of games that are possible prior to the milestone.

Are we doing the same for mathematics, and why not?

### **Mathematical milestones**

Traditionally, one pays attention that a child learns the numbers and counting, and then comes addition. This comment is supported by looking at mathematical textbooks beyond school textbooks (like those from Usborne). Moreover, one learns the numbers up to 10 or up to 20 in general. And there is not a glimpse in the „beyond“. Like mentioning the existence of further numbers or in general of mathematical objects (but you would speak to a child about an elk without seeing neither a real elk nor a picture..because all will be clear later on, and at least the child gets an elk “placeholder“ and curiosity for later, and has the word already at hand). Some thoughts:

Learning numbers up to 12 allows to read the hours on a clock, conversely a clock is motivation for learning the numbers up to 12. Why do we stop abruptly at 10? One can name eleven and twelve even if one does not represent them with fingers...

A child can be given a calendar so that it is introduced to the numbers up to 31 and sees their utility. The step from numbers up to 20 to numbers up to 31 is not that big...

A child can be presented with Bingo to learn the numbers up to 75 and play with them. To get placeholders at first, and eventually learn them properly.

Knowing two-digit numbers is more useful than knowing addition: at an early age addition only spares some time while counting, while two-digit numbers can be encountered, for example, as street numbers of houses or as prices.

The numbers 0 and -1 can be learned before two-digit numbers.

Some books for older children are accessible to younger children if one removes the arithmetical operations which are here and there and everywhere, and not in a dedicated chapter only. Moreover, such books have too much text. I would suggest that books for non-school “study” (exploration and games being more appropriate than study here) need to be categorised into competences rather than age.

Moreover, if there is an accompanying adult, there is not a real danger that the child is exposed to something too difficult... the adult will navigate and can explain or skip.... The adult can extend the boundaries of known territory and the comfort zone in all accessible directions. Clearly a new milestone will open up a lot more possibilities...

### **A young child can learn geometry**

Distinguishing a leopard from a jaguar is probably more difficult than learning some basic shapes. And learning these is also memorising words, which is a speciality of young children. Moreover, distinguishing an S from a Z is probably more challenging than distinguishing an isosceles trapezoid from a rectangle. Children can also learn about symmetry of geometric plane shapes. They can also play with tilings as geometrical puzzles or as building blocks.

A child also understands the concept of angle (more or less pointy), can distinguish triangles in skinny and not-skinny. They can tell whether two sides are equal or not, they can count sides. They can distinguish between straight and curvy, they understand directions, and parallelism, and crossings, and foldings...

They can also learn about solid geometry, and for example get to know platonic solids as dices.

Unfortunately some textbooks suggest: a square is not to be considered as a rectangle; a kite has the shape of a rhombus; a cone is a triangle. Alas. Common mistakes.

In any case all this nice, interesting and still intuitive geometry is only to be found in texts for older kids, with many words and with lots of additions in between. Can we not have a geometry almost without words (no words beyond the objects' names)?

### **A young child can learn sets and logic**

A young child can understand sets and basic set operations. They can also understand multisets, which are totally useful in practice and sadly totally neglected.

They can understand logic words like "and" and "or" and "either or", for example with fruit compotes that contain different kinds of fruits.

They can also understand simple algorithms, as a cooking recipe is also an algorithm... They can solve, with assistance, easy Sudokus and exit labyrinths on paper... they can do dessin d'enfants with numbers in their number range... They can use a balance scale...

They can also understand various kinds of diagrams...

They can play tic-tac-toe, and simplified card games. Some of them play chess better than you do...

### **A young child can learn numbers**

Young children can understand negative integers close to zero. They can understand even and odd numbers. They can understand the ordering of numbers, so the "less than" or "greater than". They can understand number sequences.

A young child can also learn unit fractions before addition. Because unit fractions are about dividing a pizza among children (and the displayed number in the denominator is simply the number of children), and that is quite intuitive when working with appropriate hands-on educational material.

A child can also understand proportions with factor one before hearing about addition and multiplication. Like if 7 children eat 7 sandwiches, then 11 children eat 11 sandwiches..

### **Challenges**

Books like "Mathematics without numbers" obviously support the idea that only part of mathematics relies on arithmetical operations hence there is a lot of math to be explored before addition is needed. Can anybody make a children book "math without words" as a math gallery? Can anybody make a children book "math without addition"? That would be discarding activities from books from older children and letting cool math to be accessible to younger children.

Similarly, some 3 years old can access to activities meant for the first school class (if only one avoids addition...). However, those kind of apps need an adaptation, as for example a red mark in the progress bar in case of a mistake can be unbearable at a too early age, or because younger children need stricter time limitations to prevent frenzy.

One can see mathematics as athletics, where you need to run and jump and roll.. if some training facility is not open yet, one can and should still train all other skills...

If you use a lot of words, your child will sooner or later learn a lot of words. Nobody speaks to a child only with words up to 5 letters, because this simplification would not make sense, and it is good to expose your child to longer words: eventually they will be learned, and something remains from the early exposure.

The main message is EXPOSE YOUR CHILD TO MATHEMATICS. More mathematics than what appears at first sight is intuitive and accessible. PLAY MATHEMATICS!