# MATH IN DISGUISE

We mathematicians have to do outreach, which is (roughly speaking) *selling mathematics*. We have to sell it to politicians that have to finance education and mathematical research, convincing them that it is key to our society's development, and that critical/logical thinking, let alone problem-solving in general, has a positive impact on society at more than one level. And mathematics also serves other sciences as a tool, it is more and more vital in a more and more digital world…this is not bluffing, and the selling is pretty easy.

We also have to attract pupils to mathematics, and studies suggest that outreach should start at an early age, let's call this *early outreach*. Maybe the easy explanation is correct, namely: most children are not born with mathematical anxiety, they just inherit it from culture and parents and (sadly) educators. And once the *math phobia* is there, even the next thing to be learned seems an impossible task for which the pupil does not believe to be capable of.

In some sense, a child simply learns how to walk by trying and falling, and most parents are supportive and encouraging. Because they see the necessity of the struggle, and also because they are usually neutral to the topic. Why cannot this be done for mathematical skills, also necessary to succeed in a digital world? Again the easy explanation could be correct: parents are not at ease, they have hidden (or less hidden) frustrations, have suffered humiliations because of mathematics (e.g. bad grades that never became good). Most people have learned how to deal with mathematics in the sense they learned how to *survive mathematics:* avoiding it as much as possible in their school studies choice, learning the absolute minimum (*exam-tailored learning*) with the aim of getting the least sufficient grade not preventing school graduation, relying on a calculator, and so on. So how to sell mathematics to these people and their children?

In fact, those children hear two opinions: the math-phobia opinion and the scientist outreach opinion. Who wins? As children are used to trust their parents more than other adults, it is clear that one should convince the parents as well to some extent. (As an aside remark, the fact that pupils coming from some countries are better at mathematics could be explained by a societal attitude, for example reflected into chess being played by the general public). However, there is a third way beyond "fight or flight", let me call it "disguise". Namely, one can train logical skills without selling the exercise as a logic exercise but rather as a non-mathematical game. Or, one trains counting skills and numbers which activities that are not part of the mathematical hours (they could be languages or sports or arts or music…). We need to invest some effort to build this "math in disguise", to trick the math-phobia and prevent allergic reactions from parents.



*wordle: a nice example of "math in disguise"*

One first example would be replacing an assisted game of MasterMind for small children by an (assisted) wordle game: the latter is less geeky and it needs also language skills to be mastered, in some sense it is *interdisciplinary*. But the logic of the game is the same, so nothing is lost. Another advantage of wordle is that it can be used when children are learning to read/write, so the typing challenge is also a learning advantage.

Can we invent and promote more "math in disguise" and "interdisciplinary math" to help the inclusion of less math-enthusiast children and to get more learning support from non math-enthusiast parents? Some ideas (to be developed in the future):

- Alphabetical ordering is an ordering, so training it is similar to the ordering of numbers. The exercise of filling the gap in the sequence 4 5 _ 7 8 or L M _ O P are logically the same exercise (like the exercise of conjugating verbs in different languages).
- Count the number of occurrences of the letter O in a given word, this is counting (and recognition of symbols, and understanding of the game rule).
- Partition a list of words according to the amount of letters O that come into it. Partition is a mathematical term and an important concept.
- Set theory: select the words that contain an O and an N (this is an intersection); select the words that contain an O or an N (this is a union); select the words that contain an O but not an N (difference of sets); the words that contain an O and those that do not are complement sets.
- The App Anton currently has for example an exercise that asks to select, among four words, the one not containing the letter O. Negation is logic.
- One could invent riddles, like: select among the following words the one which means an animal, has less than 7 letters, and has the letter O precisely once.
- Other interdisciplinary similar logic riddles would be identifying an animal (like "Guess Who (is the animal)?") The animal swims but does not fly, is small and has four legs. That would be a biologic and logic exercise that can easily be tailored to the age or skills of the pupil (all above exercises can be easily adapted to different levels of pupils).
- Comparing sizes or other quantities is also a mathematical skill that can be presented in a non-mathematical way (e.g. Which children have long trousers? Which child has longer trousers? Which child has the longest trousers? This can even be sold as a grammatical exercise on the comparative and superlative).
- Spatial orienteering can also be trained in a non-mathematical setting, with normal games.
- Symmetry can also be trained on letters, for example making the puzzle where each letter is cut in two (vertically or horizontally) and something like 5 letters have to be recombined (possibly some pieces are mirrored, or the child has to select what the shape would be if the letter is written on the other side of a glass window,..).
- Grids with rows and columns having some non-mathematical meaning and that have to be completed is a non-mathematical easy Sudoko.

*Summary: Early school mathematics is interdisciplinary, and we should investigate ways of hiding it into other subjects. For example, making language exercises that train logic skills. Let's put mathematics in disguise: this can be a way of not triggering mathematical anxiety while developing mathematical skills.*