A CHALLENGE FOR YOUR SPATIAL VISION: ARE WE ABLE "TO SEE" SIMULTANEOUSLY MORE THAN THREE FACES OF THE SAME DICE?

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Summary:
Mathematics can be surprising and, lucky, this mathematical surprise is shown from time to time in the simplest details and turns out to be nearby for everybody. Generally it is not exclusive to mathematicians, and is accompanied by optical illusions, logical paradoxes, physical principles, artistic creations or by any stroke of fantasy and imagination. We would like the reader to interact with the challenge presented in the poster and to become an active part of his/her own optical illusion. We face the reader with the problem of looking over a board by means of specific movements of a dice that the reader will build from its development in the plane. In view of this impossibility to visualize simultaneously more than three faces of this dice and using a geometric construction that originates an ingenious optic effect based on the Necker cube, the reader will need something more than his/her spatial vision to be able to resolve it. If we manage to attract your attention and curiosity, where is the trick?

VISUALIZATION

The geometry involves three classes of cognitive processes:

- **VISUALIZATION**
- Reasoning
- Construction (Duval, 2001)

VISUALIZATION (*capacity to build and manipulate mentally representations of objects of two and three dimensions and to perceive an object from different perspectives*, NCTM, 2003).

It understands (Del Grande, 1990):

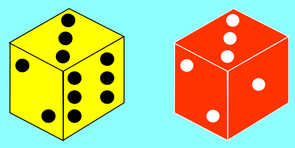
- Visual coordination and motion
- visual constancy
- visual discrimination
- perception of figure in context
- perception of the position in the space
- visual memory.

The forms and their representations are used to develop the VISUALIZATION:
"Shapes or visual representations as a means for better understanding concepts, processes, and phenomena in different areas of mathematics and science", Hershkowitz et all. (1996), p 161.

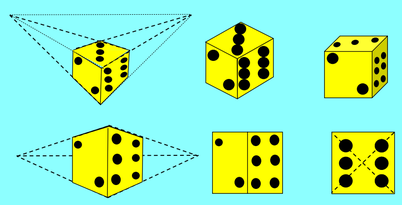
DICE

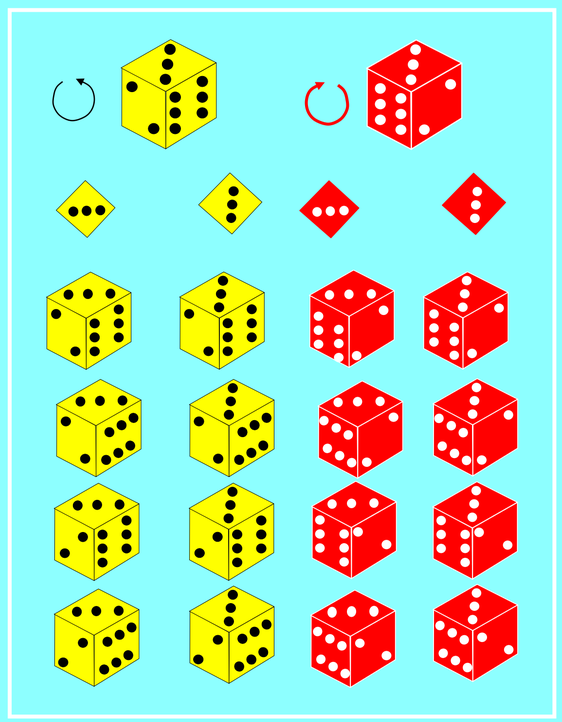
-Math usually are served of dice to study the chance
- Here is utilized to test YOUR spatial vision.

The opposed faces add 7 (couples 1-6, 2-5, 3-4).
If only we keep in mind the scoring, we will have two types of different dice.



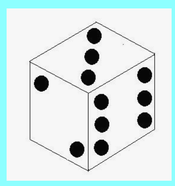
A number of each pair is totally symmetrical in its placement (1, 5, 4)
The other admits two possible placements (3 and 2 in the different diagonals and 6 in horizontal or vertical).
This gives 16 different dice.
Although it is impossible to see more than three faces of a dice, exist different perspectives since that it is univocally determined



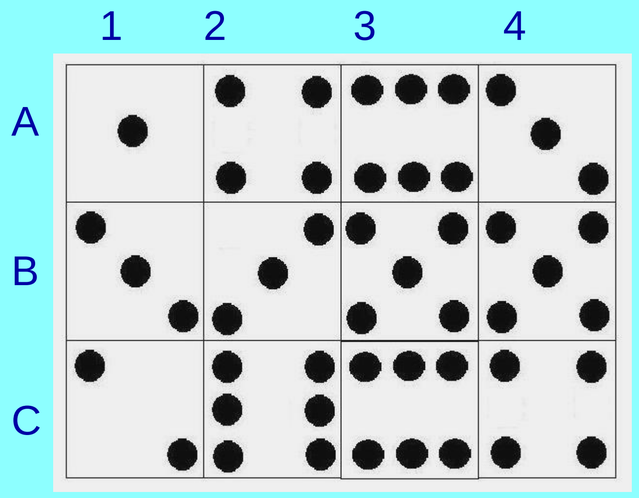


CHALLENGE

With this dice we propose you the following challenge



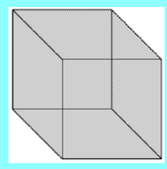
It has been placed the dice in the A-1 square of the panel, with the 1 in its upper face. Each movement of the cube consists of turning it on one of its edges to situate it in one of the nearest squares and the number of its upper face is noted. If we cannot pass two times for the same square and all of them have been crossed, which has been the way travelled through?



OPTICAL ILLUSION

Helping you to resolve the problem is convenient to have a dice. In the upper corner there is a special one. To utilize it, you have to perceive in a convex way. You should distance of the poster closing an eye to achieving it. Have you got it?

You should move slightly toward the sides and you will see the movement effect that it is produced. In a short distance, the effect is obtained closing an eye, but if we distance far away we will enjoy with the two eyes open.
If we analyze the origin of this surprising effect, we find with the duality of perception that presents the cube of Necker, admitting so much the concave perspective as the convex one:



Necker´s cube

In the vision of plane we can advance two different faces, obtaining two representations that show the Figure 1. Why the effect of movement is produced?

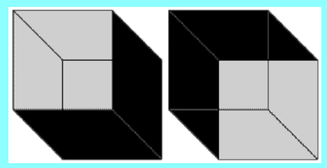


FIGURE 1

Once it exposed the origin of the illusion, we can obtain the same effect with different figures. Perhaps the most surprising one is the dragon inspired in the work of Jerry Andrus to celebrate the "Gathering by Gardner 3" in 1998.

REFERENCES

Del Grande, J. (1990). Spatial sense. Arithmetic Teacher 37, 6, 14-20.

Duval, R. (2001). La geometría desde un punto de vista cognitivo. Proceedings of the 25th PME <www.webmath.org/svt/VRML2.html>.

Herskowitz, R., Parzysz, B. and Van Dormolen; J.Van (1996). Space and shape. In A.J. Bishop et al. (eds.), International Handbook of Mathematics Education, 161-204. Kluwer Academic Publishers.

NCTM (2003). Principios y Estándares para la Educación Matemática. Granada, SAEM THALES, Proyecto Sur.

Ramírez, R. (2004). Dragones, enanos, jinetes y un divertido mundo al reves. *Revista de la Sociedad Andaluza de Educación Matemática THALES. 21,1,105-110.*

www.sandlotscience.com/EyeonIllusions/Andrus.htm