LEARNING MATHEMATICS THROUGH GAMES IN PRIMARY SCHOOL: AN APPLICATIVE PATH

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Abstract: In this work interesting results of current research about the importance of games use for learning mathematics in primary school are introduced. This process constitutes a meaningful basis for connecting the happy experience of game with the natural intuitive and scholastic mathematics during the primary school period. The application of such techniques finds a natural place in the mathematics laboratory, where children have the opportunity to live a practical approach for better understanding and using the formal one. Through games it is possible to help the crossing from early elementary operational levels to a more advanced forms of thought. In conclusion examples of games involving mathematics for all years of primary school will be also given.

Keywords: *mathematics, game, education, experimental technology, science, primary school.*

INTRODUCTION

The school is often remembered as a place where children are forced to spend a period of time, in order to achieve a qualification. The often low cultural preparation and hard skills into the world of work show that the efficiency of the school might be improved. A significant improvement can be achieved if the school, especially primary school, is able to change its formal dress through the adoption of a more playful teaching. Following this way, it has been verified that the participation of students and their subsequent profit level are significantly higher, with interesting benefits on society.

The game, as a natural and spontaneous fact for humans, is a powerful element of communication and is therefore a potential educational tool of great efficacy, particularly in nursery and primary school. Already about 2400 years ago Plato (Plato, 1961) claimed that no one discipline imposed by force can remain in a child,

therefore it is better to educate children in the various disciplines not by force, but with the game, also for better observing the natural disposition of everyone. Recently, the mathematician and educator Lucio Lombardo Radice (Lombardo Radice, 1976) stated that, for checking what the students have learned in the classroom, it would be appropriate to do an hour of intelligent games.

In order to successfully carry out its social task, it is necessary that the school looks like a fascinating place, where children are encouraged to go spontaneously. Before dealing with what to teach, it is important to ensure that students are happy in the class and not tempted to go elsewhere. For introducing a playful atmosphere in the school, the type of adopted game is not important but the playfully created atmosphere. Every objectively fun game, if introduced in the classroom as formal, becomes immediately boring and not involving, like a traditional school practice. If teaching is carried in the classroom in a pleasant and stimulating way, it can be exciting as a good game. "Well playing" means to have a taste for precision, love for language, ability to express themselves with non-verbal language, acquiring intuition and rationality, habit of loyalty and collaboration (Burke Johnson, & Christensen, 2013).

MATHEMATICS AND GAME

Mathematics is considered a dry and boring subject only to those who consider it as the discipline that teaches how to make calculations. In the process of solving a mathematical problem, calculus represents only a part of the global process; another important and exciting phase concerns the examination of the procedure. The recreational popular mathematician Martin Gardner said that a mathematics teacher, independently by her/his love for the discipline and by the force in her/his desire to communicate it, must always deal with big difficulty: "how to keep students awake" (Gardner, 1994).

One of the best ways to make mathematics interesting, in particular for primary school children, is to approach it with a playful spirit, presenting interesting mathematical games, puzzles, tricks, jokes, paradoxes, models. This does not mean that a teacher has to superficially entertain their students, but on the contrary a mix between seriousness and fun; fun keeps awake the interest, seriousness justifies the fun.

In mathematics education the use of recreational proposals allows us to pleasantly solve problems of varying complexity and thereby provides a means of study motivation, which is much more engaging than many traditional methods which are often discouraging to students. In particular, one can be very effective in the execution of problems and mathematical reasoning by placing them under the aspect of game. Using such games without explaining the trick, but inviting children to search for it, the innate human discover tendency leads them to diligently apply themselves. At primary school level, children connect abstract concepts with practical experience in a more concrete way, and they live them intensely with game (Di Sia, 2013a).

LEARNING BY PLAYING

The game helps children to learn mathematics, applying abstract concepts to everyday life. It is also useful because it develops the self-esteem and avoids their consideration of mathematics as a boring and difficult discipline. The brain well incorporates mathematics concepts through the game and makes them easily accessible to children.

The action is fundamental for the development of primitive mental categories, as the concepts of space and time and the development of logic, all involved in mathematics learning. Children should be free to experiment and make mistakes, but parents tend often to be over-protective, not considering the difference between protecting your child and preventing growth with own experiences and making mistakes. In this way the child is not educated to autonomy, with a negative impact on the academic performance but on the love for the study.

Some choices, seemingly very far from mathematics, can affect the easiness with which this subject will be followed. For example, the delay for the age of the "potty", leaving the baby with nappy up to three years, complicates the acquisition of concepts such as "inside-out", which are essential for geometry. Current research recommends therefore to leave children freedom to experiment, to play games, becoming aware of the body and of the space around them.

The experience is essential for the learning of scientific disciplines, and it is their practical use to make them useful and interesting. For avoiding a "recited mathematics", without the knowledge of the underlying concepts, a method for teaching is then its application to real everyday life, using also games as a teaching tool. The stress by mathematics is prevented developing the self-esteem. It has identified a real phobia emerging among today's children, just called "stress by mathematics" (Ashcraft, 2002).

Research has discovered that some children, when they are struggling with numbers, activate the same brain areas, that are turned on in those suffering from the most common phobias. The best way to combat this problem is not to label the child as incapable or to force her/him to do more mathematics; this would only increase her/his anxiety, but it is rather better to teach them relaxation techniques and to help in increasing the self-esteem. In childhood this means essentially to perceive the esteem of others and to be praised for work well done . This means also to provide examples of success, to reassure them of the fact that mathematics is accessible to everyone, avoiding justifcation of failure on the grounds that it is a "difficult discipline" (Di Sia, 2013a; Di Sia, 2013b).

THE DIDACTICS OF THE LABORATORY

The didactics of the laboratory is intended both as a physical place, and as a moment in which children are active, discuss and argue their own choices, build meanings, learn to collect data and to compare them with models. The laboratory is not only specific for the experimental science, but it is also an appropriate place for learning mathematics as a type of adopted game,

Mathematics is not a static reality, but it has a history and is constantly changing. It is important for validating the experience and knowledge of children, the discovery, the collaborative learning. This learning must also be done through practice, exploration, development of thinking and as a way for building knowledge (Marinas, & Clements, 1990).

Equally important is the development of procedural skills (mental, written, graphic, with computational tools), the memorization (for example of definitions and properties of mathematical objects), and globality of mathematics as theoretical construction (Bascones, & Novak, 1985; Walshaw, 2010; Di Sia, 2014).

EXAMPLES OF MATHEMATICS GAME ACTIVITIES FOR THE PRIMARY SCHOOL

We consider for every class of the primary school (five years in Italy)there should be examples of laboratory activities of mathematics in the form of game, involving both arithmetic - examples (a), and geometry - examples (b). For every example useful modifications are possible; in particular, it is interesting to give freedom to children, for a better understanding of the gained knowledge both of the covered topics, the remaining difficulties.

1. First class: approach to quantity and first elements of geometry in 1-D and 2-D.

(a1) We play with numbers: circle only the numbers (Fig. 1).

Fig. 2. Playing with numbers. Source: personal elaboration.

(a2) We play with lines: start from zero and connect the numbers to each other (Fig. 2). What will you see?

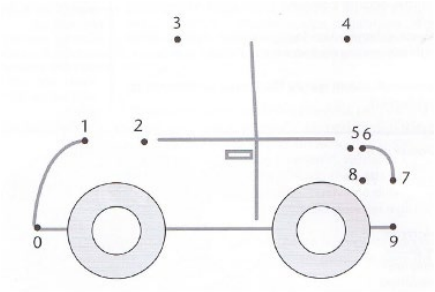

Fig. 2. Playing with lines. Source: personal elaboration.

(b) Which will be Maria's house (Fig. 3)?

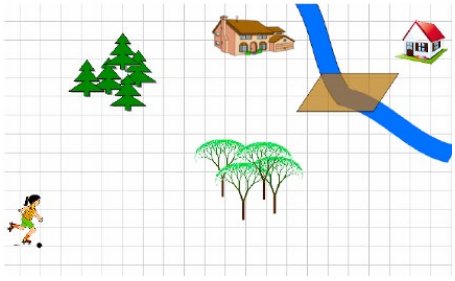

Fig. 3. Maria goes home. Source: personal elaboration.

To find the house, follow the path shown in the tables (Fig. 4):

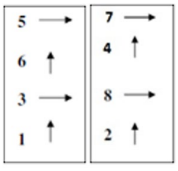

Fig. 4. Arrows showing the path. Source: personal elaboration.

2. Second class: numbers with tens and first elements of 3-D geometry.
(a1) We play with the hours: what is each clock indicatingŷ (Fig. 5)?

morning morning afternoon evening
(for 1st read of the clocks)
afternoon evening morning morning
(for 2nd read of the clocks)

Fig. 5. Playing with clocks. Source: personal elaboration.

(a2) Complete the sentence (Fig. 6): in the morning Maria goes to school at ....., she enters in the classroom at ..... and she returns home at .....

Fig. 6. Playing with hours. Source: personal elaboration.

(a3) Draw the hands corresponding to the indicated time (Fig. 7).

Fig. 7. Hours and minutes. Source: personal elaboration.

(b1) Make Pinocchio coloured as you see in the indicated forms (Fig. 8). What forms are we talking about

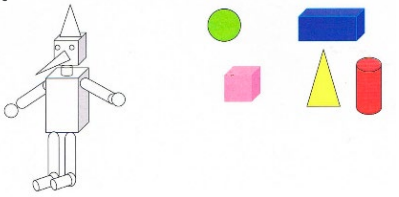

Fig. 8. Coloring Pinocchio. Source: personal elaboration.

3. Third class: operations with numbers and advances on solids.
(a) We play with animals: for each grid write 2 operations with "+", 2 with "-", 2 with "x", 2 with ":" (Fig. 9).

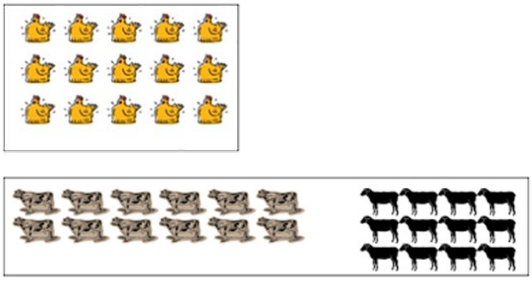

Fig. 9. Playing with animals. Source: personal elaboration.

(b) Write below each object the name of the solid which has the same shape (Fig. 10). Write for each solid its features.

Fig. 10. Playing with solids. Source: personal elaboration.

4. Fourth class: advances in calculus and classification of figures.
(a) We play with divisions: perform the divisions and colour according to the obtained results (Fig. 11).

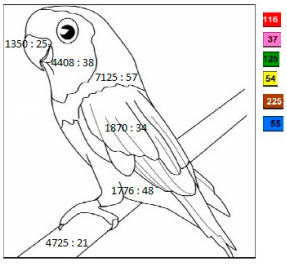

Fig. 11. Playing with the parrot. Source: personal elaboration.

(b) We play with figures: observe the classification of quadrilaterals and answer the questions (Fig. 12).

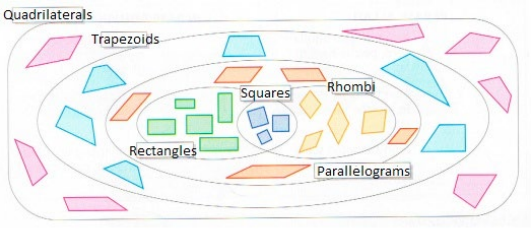

Fig. 12. Playing with quadrilaterals. Source: personal elaboration.

What are the names of quadrilaterals with at least two parallel sides?
What are the names of those with two pairs of parallel sides?
Why does the square belong to the set of rhombus? The
The rhombus is a square? ..... Why?
The square is a rectangle? ..... Why?
The rectangle is a square? ..... Why?

5. Fifth class: advances in number operations using problems.
(a) We play with money: discover the price of every fruit (Fig. 13).

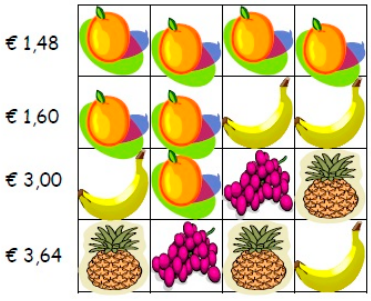

Fig. 13. Playing with money. Source: personal elaboration.

(b) We play with the mole (Fig. 14): the mole, finished her lethargy, decided to leave her lair. She excavated a vertical tunnel 7 meters long. Every day she excavated 1.5 meters, but every night, due to slipperiness of ground, she fell 30 centimeters back down the hole . How many days did it take to get out of the tunnel (Polya, 1973; von Glasersfeld, 2001; Contant, Bass, & Carin, 2014; Di Sia, 2015)?

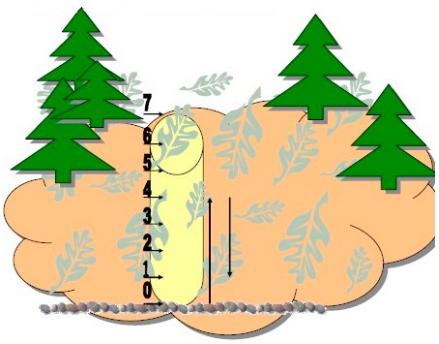

Fig. 14. Playing with the mole. Source: personal elaboration.

CONCLUSIONS

The use of games as a laboratory for mathematics is an interesting tool in the process of learning mathematics, in particular in the primary school. The indicated material can have useful modifications and adaptations, in relation to the individual situation of the class. The link with the game stimulates the imagination of children through a fun approach to mathematics; in this way mathematics is perceived as a helpful and fun discipline. Children can work individually, in pairs, in groups with inhomogeneous levels of learning, with a mix of previous modalities. In relation to integration, children with disabilities can be usefully included in the groups with the mentoring teacher support.

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