FAIRY TALES IN PRIMARY SCHOOLS: MATHEMATICAL THINKING THROUGH CREATIVITY, FANTASY AND IMAGINATION

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Abstract
Our research aims to investigate on creativity and imagination as possible artifacts for maths learning. In particular, we aim to understand if fairy tales can be used as artifacts for trying to find out whether children had previous mathematical knowledge or not, and as tools for developing knowledge, skills and abilities in the creation of imaginary settings. In this paper we claim that there may be an edge between imagination and creation of a reality that can lead to achieve mathematical notions in a creative way.

Keywords Mathematical fairy tales, imagination, mathematical thinking

1. Introduction

Our paper aims to study the links between imagination, fantasy, creativity and mathematics in order to determine how these factors, when they integrate, give primary school children the chance to embark on a journey that will lead them to discover how mathematical thinking can become better or stronger. In fact, the investigation and the enhancement of mathematical creativity are among the priorities of all educational systems and research organizations [1]. Some questions have therefore strengthened and supported our research:

- can creativity and imagination allow children to construct their mathematical thinking?
- can the creative activity of students, with minimal interference from their teacher and with fairy tales as artifacts, help or foster the construction process of mathematical concepts?

The fantastic setting of the fairy tales helped us to find an answer to the two questions above, since fairy tales can allow children to show their strong creative capacity, because they help them detach themselves from the reality that surrounds them.

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2. Theoretical framework

The ideas which are suggested as a possible explanation for our research are the following: creativity and imagination as possible artifacts for maths learning; fairy tales as tools for trying to find out whether children had previous mathematical knowledge or not and as tools for developing knowledge, skills and abilities in the creation of imaginary settings. Even if children start from a stereotyped fairy-tale world they could manage to develop new fairy-tale situations.

We also try to prove that, in practice, at school, imagination can produce situations. On the other hand creativity can solve problems. Therefore a change in routine events that tells us that learning has occurred will be encouraged [2].

Before defining creativity, it seems necessary to describe what the creative activity of imagination is like. Imagination is a common heritage of every man and it "is even a necessary condition of everyday life" [3].

Moreover, the creative activity of imagination depends directly on the wealth and variety of the man previous experience, since this experience provides the things, events and ideas that are used as a basis for imagination [4].

"Imagination is therefore made up of things, events and ideas based on fact" [4] but imagination develops more and more by combining elements based on fact with elements based on imagination and "the last elements that will make up the most imaginary picture, which is also the most remote from reality, will always be nothing but feelings based on fact" [4]. There may be an edge between imagination and construction of a reality that can lead to achieve mathematical notions in a creative way: this edge is the most important element upon which our study depends.

This creative activity is "synonymous with divergent thinking, that is able to do completely different experience from what has been done before, so as to constantly break the old patterns of experience" [3]. This thinking is basically in contrast to those who experience situations with no dangers, but it is, on the contrary, capable of independent judgement, finding problems and asking questions to find answers that are not always satisfactory and therefore it "reworks and rearranges objects and ideas without becoming inhibited by conformism" [3]. As far as mathematical thinking is concerned, creativity involves "divergent and convergent thinking, problem finding and problem solving, self-expression, intrinsic motivation, a questioning attitude, and self confidence" [5].

With reference to mathematics, one of the most typical features of this creative activity is that "it does not occur in a vacuum, but in a social environment. Mathematics learning may be perceived as a combination of individual creative (or re-created) acts taking place in a social environment, which somehow influences, by praising or rejecting, all significant choices made by students" [6].

The "social and cultural" environment of the group of children, which is the main focus of our study, belongs to well-defined edges, but these edges may still be overcome so as to achieve common – and even more complex – mathematical notions.

Some authors have given different meaning to creativity and its relationship with mathematics. Mathematical creativity can, for example, be considered "as the ability to solve and pose problems with heuristic methods, to observe patterns with numbers or shapes, to generalize mathematical notions, to apply non-algorithmic processes for decision making, and to handle information and processes flexibly" [7] [8].

Moreover, creativity can be described as the process of "becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses or formulating hypotheses about the deficiencies;

testing and retesting these hypotheses and possibly modifying and retesting them"; and finally communicating the results [9].

The definition given by Torrance can be applied to the notion of mathematical creativity. Mathematics meant as a creation of the human mind, something that can be learned only by creating it. Children who learn mathematics, that is a subject they do not know about, act as researchers, which means involving all their qualitative and quantitative resources and experience in the creative process [6].

3. Methodology

The project was carried out in the second-year (13 children) and third-year (9 children) classes of the primary school "Istituto Comprensivo San Giovanni Bosco" in Massafra (TA). The project required 30 hours in the afternoon divided into ten weekly meetings of three hours, during which children were divided into groups of three/four and worked together.

The first methodological aspect aimed to help children write creatively according to a pattern suggested by F. Dickens and K. Lewis in their handbook "The Story Maker" [10]. Our proposal consists in answering some questions in a constructive way. Here are some questions:

- What kind of story are you thinking about?
- Which characters are involved in your story?
- Which emotions and feelings are caused by the characters in your story?
- How big or small are the places in your story?
- Which physical features have the characters in your story?
- What the characters are talking about?
- How do the characters move in your story?
- Where is the story set?
- Which objects are found in your story?
- How does the story take place?
- What's the weather like?

Answers to the questions above have shown knowledge and, above all, gaps in language issues, and in the mathematical notions of number, odd and even numbers, prime and compound numbers, recognition of regular plane geometric figures according to their properties and they have also highlighted great difficulties with subjects relating to measures.

We have therefore organized lab recreational pursuits to help children to overcome the difficulties they had faced and try to get a complete understanding of the above-stated notions by suggesting problem posing and problem solving situations.

The Inquiry Approach method has finally allowed the redefinition of all the elements from which stories are formed, the recovery of most of the difficulties, and the creation and representation of the "tale of tales", a product of the children creativity and imagination by connecting every single fairy tale.

4. The teaching experiment

The teacher started by asking the following questions: "What kind of story are you thinking about?" and "Which characters are involved in your story?"

After a few minutes of consideration Daria says: “Once upon a time there was a castle…and in this castle lived a princess named Bella. She was very poor and her father name was Salvatore…she lived in a wood having a lot of trees” and Vincenzo, one of her fellow students, adds “it was 1400, in July, and there was an earthquake on 27th April.”

On the contrary Pasquale, a student by another group, intervenes and says: “Our story takes place, on the contrary, in the savannah. In July 2001 a turtle met a rabbit and a hare. The turtle asked: “How do you survive?” and the hare replied: “We found a magical lake behind that tree. A lion appears from the forest and meets the three animals.”

Arianna intervenes and says: “In our group the story tells, on the contrary, that once upon a time the princess of the numbers had 10 towers and in her village there was the fairy of the numbers that fulfilled all desires. There lived also an old witch who had the intention to attack the city.”

As you can see, when children have to set their stories they refer to worlds of fantasy that exist in well-known fairy tales told by adults. Even Arianna who tries to escape from stereotyped tales, inventing an imaginary country of the numbers, still introduces classic characters like princesses, fairies and witches.

The next step concerns the questions relating to the definition of places, their shape and dimension and to the physical features of the characters. When they had to reply to those questions children gave vague replies about geometric shapes and, when it came to the characters, these replies were sometimes meaningless. For example, “Daddy Salvatore is only 42 cm high” while “princess Bella is of average height and lean 35 and 130 (numbers are not better specified),... the poor is of average height and skinny 25 and 125”. “The turtle is small and is 3 cm high and weighs 100 kg,... the hare is 50 cm high and weighs 27 kg”. “The lion is 1.65 meters high and weighs 100 kg”. “Princess 100 of the kingdom of the numbers is tall, light as a feather and has light arms and legs. Fairy 9 is tall and light, has strong legs, strong arms and long neck. Witch 8 is tall, with heavy arms and legs”. As in the case of shapes, the castle is “square-shaped”, the shape of the magic kingdom is rectangular, windows are square, the door and the balconies are arched, garden is rectangular and rooms are square. Savannah is shaped like a rectangle and is in Africa that has the shape of a trapezium. “Mathsland City” has a flat and vertical shape. As you can notice spatial dimension as well as a right perception and knowledge of plane figures are lacking in their stories. What’s more, the iconic symbolization and their drawings of places and characters have an influence on the answers they have given previously.

The next question concerned the temporal dimension of their stories. According to their first answers, it seems that children have no perception of time when they describe their stories, such as for example: “the lunch of the animals lasts one hour”; “the lion spends a day and a half to build the ship”; “the fairy tale lasts one day but three hours pass in the story”; “the inhabitants take an hour to get themselves organized”.

All the difficulties that children had run into have been used as a basis for some situations of games aimed at retrieving the geometric aspects found in the drawings of their fairy tales and using other well-known children’s stories to bring out the time development of days, months and seasons. We have also organized some recreational pursuits such as arithmetic operations in the form of games aimed at identifying odd, even, prime numbers and mathematical operations and their meaning, by assuming that arithmetical issues can stimulate the children’s imagination thus introducing new imaginary elements in the fairy tales sketched before. Our intention was to check what stated by Vygotskij on the experience and knowledge that can provide children with elements for their imagination. One of the games suggested is “Meow – Woof”: children have to answer Meow if the number said by the coordinator is odd and Woof if the number is even. Sitting in a circle, children give their answers when it’s their turn and if they give a wrong answer they give up playing at least

temporarily. Those who go on playing without making any mistake until the end of their 15-minute playful game win and gain their point. Children who are sitting in a circle have reinforced the notion of odd and even numbers. This playful game is also important because it shows children how to respect the rules, waiting for their turn, and their rival playmates. At the end of their playful game children have written notes in their notebooks, given the definition of odd and even numbers and used suitable drawings as in Fig. 1 and Fig. 2.

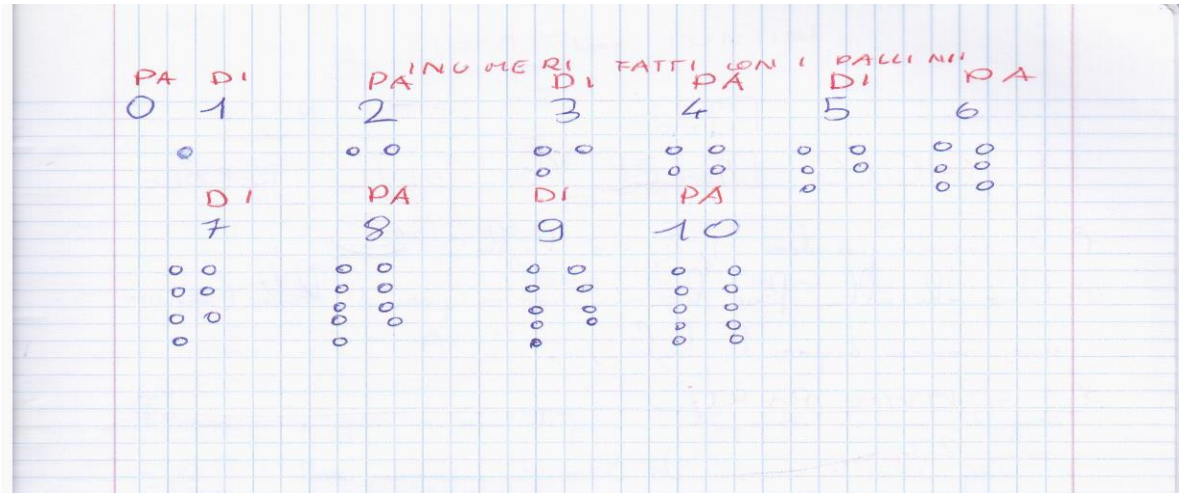

Figure 1: "Numbers with dots"

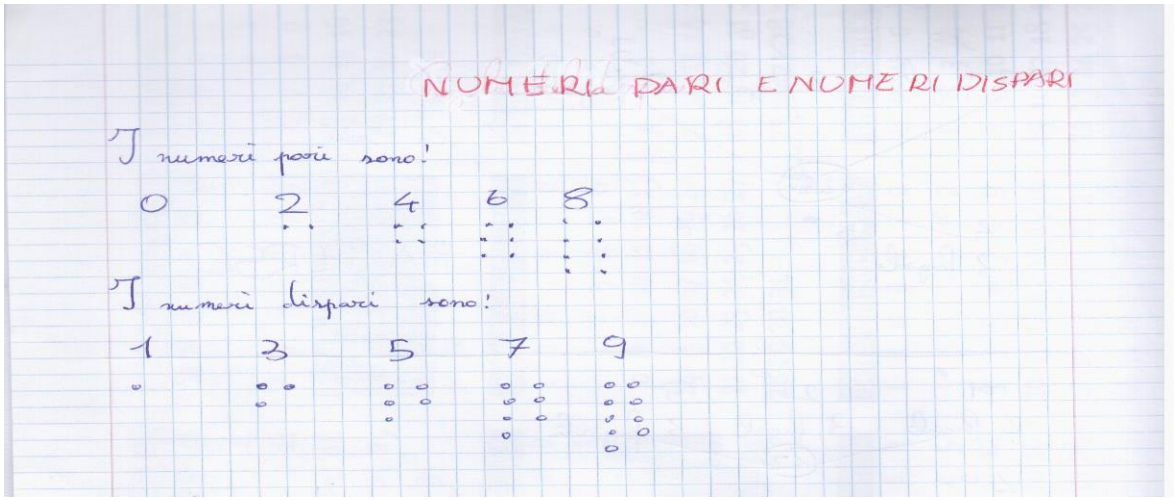

Figure 2: "Even numbers and odd numbers"

Another playful game we have used is "the sum of beans." The aim of this game is to get odd or even sums according to what had been fixed before by taking 1 or 2 or 3 beans for a set number of laps. This implies that children know the notion of odd and even numbers, and are also able to predict and interpret the result of the sum in the event of only even addends, only odd addends and both odd and even addends. As far as geometric figures are concerned we have used the "dear friend I'm writing to you" game, whose aim is to get the playmate to draw a shape or a geometric figure through the description of its features, by writing a letter. The result that it is intended to achieve is the learning of mathematics in a social environment that approves or rejects all actions done by a student, according to Checcucci [6]. And finally, thanks to an activity known as "invent the question" we have started a debate among children about the different ways of solving a problem with regard to the different questions that a problem may stimulate.

Here is an example: “there are 30 chalks left in the box, 10 have been used during this week. Invent the question!”. This activity aims at helping children to express independent opinions and thoughts when they try to find answers that may seem unsatisfactory, and leading them to work out and reformulate objects and notions without being affected or influenced by any kind of conformism, as Rodari [3] and Mann [5] point out.

As for the difficulties concerning the notion of measurement we have spurred children to observe thoroughly their bodies, the body of their teacher and that of some adults in order to look carefully and realistically at the physical aspect of the characters of their fairy tales.

5. Last stage and analysis of the results

These activities have let children be more and more satisfied with the old and new skills and matters they got and studied in depth; we have also noticed that children were eager to use them in the surrounding environment and in the relationships with their playmates: “Which shapes and figures are found all around us?”; “I challenge you to play with beans”; “So, do our fairy tales, our characters, the places invented by us for these fairy tales have to do with what we have learned these days?”; “If we put together all the characters and their stories what can we get?”. Hence the idea of the “tale of tales”. Places have taken important and consistent shapes and figures, characters have acquired more and more realistic features and size and, above all, children’s fantasy and imagination, thanks to the arithmetic and geometric knowledge they got, have given to princess 100, sorceress 9, witch 8 and all places of their fairy tales some roles connected with an arithmetic and geometric meaning: princess 100 welcomes and protects all the characters involved in her kingdom “because 100” as Arianna says in an interview “can be got as the sum of odd, even and prime numbers and it is a number that dominates because it is big”. “Witch 8, on the contrary, who hates odd prime numbers” as Daria says “in trying to destroy the “magical kingdom” transforms the characters into the numbers 3, 5, 7, 11, and so on because she wants to isolate and weaken them... sorceress 9 helps princess 100 and the inhabitants of the magical kingdom to solve problems because she is an expert on the casting out nines”. Children have therefore motivated their choices.

6. Conclusions

As Sfard [2] has pointed out, the way that learning activity develops has changed since fantasy and imagination have allowed children to learn new notions through recreational pursuits and activities of challenge. The study we have carried out shows in real terms the idea of mathematical creativity pointed out by Torrance [9], Silver [8] and Sheffield [7] who identify mathematics learning only through a creative activity. The idea of the “tale of tales” has allowed children to take the role of researchers in the creative and constructionist process that exploits qualitative and quantitative resources and experience, as Checcucci [6] has stressed.

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