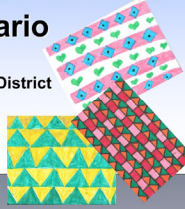
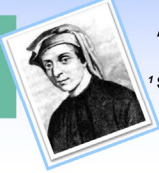


EDEN Open Classroom 2016: Open Schools for Open Societies Patterns and the Fibonacci numbers –

An Educational Scenario

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Introduction

Under the European programme Inspiring Science Education (ISE) an educational scenario was created, which is strongly related with the history of Mathematics. It is targeted at learners' familiarisation with Leonardo Pisano or Fibonacci, the most important mathematician of the Middle Ages, through their exploration of the mathematical pattern he discovered in the 12th century. As a result of their involvement with the pattern, they can observe how impressively these patterns can be applied to nature.

The scenario is aimed at children aged 10-12 years old. It was implemented in 11 primary schools, eight of which belonged to the 11th Educational District of the Primary Level of Education in the Region of Thessaloniki in Greece. 22 teachers and about 500 students were involved.

Objectives

1. To understand the meaning of a pattern and locate different kinds of them.
2. To familiarise with the Italian mathematician Leonardo Fibonacci, his biography and his work.
3. To get familiar with the sequence of Fibonacci numbers.
4. To become young researchers and to re-discover the sequence of Fibonacci numbers through the use of mathematical examples and observation in nature.
5. To realize that mathematics is not a pre-existing knowledge, but a knowledge that has been evolving since its discovery.
6. To love Maths and experience its charm.

Methodology

The methodology followed was Inquiry Based Learning. A methodological approach which is used in ISE and it's corresponding template. "There is a variety of conceptualizations of the process of inquiry learning in the research literature. ISE's instructional model of Inquiry-Based Science Education consists of five learning activities: Orienting & Asking Questions; Hypothesis Generation & Design; Planning & Investigation; Analysis & Interpretation; and Conclusion & Evaluation." (Stylianiidou 2015, p.10) The aforementioned five steps were used in order to create the discussed scenario.

The Educational Scenario

<http://www.opendiscovery.space/el/edu-object/ta-motiva-kai-oi-arithmoi-toy-fibonacci-842434>

1. Orienting & Asking Questions -Patterns in everyday life

Do you know what a pattern is? Could you mention patterns you meet in your everyday life? Watch carefully the following pictures and find the pattern.



In which courses have you noticed any patterns? What do you observe in the following figures (in which courses have you come across them)?



Watch the following pictures and mention patterns you meet in other cultures.

Idea! Create a pattern exhibit by bringing items with motifs from home, collecting various images from the internet and making your own patterns as well.

2. Hypothesis Generation & Design -Types of patterns

Children meet different kinds of patterns-number patterns, pictorial/geometric patterns, simple patterns, complex patterns, repeating patterns, linear patterns, etc. and they are engaged in exploring the pattern each time. Various websites are recommended to the children in order to practice and distinguish the different kinds of patterns they have already met.

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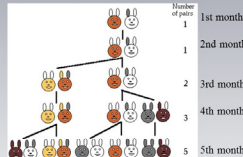
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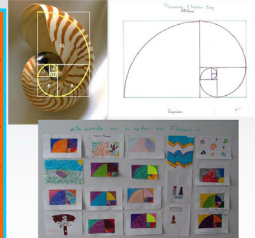
3. Planning & Investigation -Fibonacci Numbers & the problem of Rabbits

This was the fictional problem being considered by the great Middle Ages mathematician Leonardo Fibonacci. Would you like to become a young mathematician and try to solve it?
"Given two adult rabbits, how many pair of rabbits can we imagine being produced in a year's time if every month each pair begets a new pair that from the second month on is productive?" (We assume that rabbits never die or get cooked!)"



Could you write down in a sequence the number of pairs of each month? **1, 1, 2, 3, _____**.....
This sequence of numbers is called **Fibonacci Sequence**. Watch carefully the numbers of the Fibonacci Sequence. Can you discover the pattern? **1, 1, 2, 3, 5, 8, 13, 21, 34, ...**
The total number of pairs of rabbits (adult+baby) in a particular month is the sum of the total pairs of rabbits in the previous two months:
2=1+1, 3=2+1, 5=3+2, 8= +, 13= +, 21= +, 34= +

Rectangles and Shell Spirals
1. Draw two small squares of size 1 next to each other.
2. On top of both of these draw a square of size 2 (-+1+).
3. Then draw a new square -touching both a unit square and the latest square of side 2- so having sides 3 units long, and then another touching both the 2-square and the 3-square (which has sides of 5 units).
4. We can continue adding squares around the picture, each new square having a side which is as long as the sum of the latest two square's sides.
This set of rectangles whose sides are two successive Fibonacci numbers in length and which are composed of squares with sides which are Fibonacci numbers, we will call the **Fibonacci Rectangles**.
Then draw a spiral in the squares, a quarter of a circle in each square.



Divide each term of the Fibonacci Sequence by its preceding term. Watch carefully the outcomes! What do you notice?

5:3= 8:5= 13:8=1,625 21:13= 34:21= 55:34= 89:55= 144:89= 233:144=

4. Analysis & Interpretation-Fibonacci Sequence in nature & the golden ratio

Carefully look at the following pictures and count the petals of the flowers. Is there a pattern?



In the pinecones pictured, how many spirals can be seen to be ascending up the cone in a clockwise direction and how many spirals ascend more steeply in a counterclockwise direction?



Idea! Create your own scrapbook of flowers and categorize them by number of petals so as to follow Fibonacci's Sequence!

If you divide each term of the Fibonacci Sequence by its preceding term then.... As we go further out in the sequence, the proportion of adjacent terms begins to approach a fixed limiting value of 1.618034... This is a very famous ratio with a long and honored history: the **Golden Mean of Euclid and Aristotle**, the divine proportion of Leonardo da Vinci, considered the most beautiful and important of quantities.

Discuss with your peers where the Fibonacci Sequence is met. Find more information regarding the Sequence. Children to realise that:

The Fibonacci numbers appear everywhere in Nature, from the leaf arrangement in plants, to the pattern of the florets of a flower, the bracts of a pineapple, or the scales of a pineapple. The Fibonacci numbers are therefore applicable to the growth of every living thing, including a single cell, a grain of wheat, a hive of bees, and even all of mankind.

5. Conclusion & Evaluation

- In groups find information on Leonardo Pisano Bigollo and write his biography.
- In groups conduct a fictional interview with Leonardo of Pisa.
- In groups create a poster of the Fibonacci Sequence.
- Individually summarize your impressions regarding the Fibonacci Sequence and then share them with your classmates.

General Conclusions

- Children had the chance to get familiar with Fibonacci and his number sequence, to revise their knowledge regarding patterns, to re-discover Fibonacci numbers and their application to nature, to create relevant posters, to draw spirals, etc. ... but the most important to be happy and excited while doing Math!
- Teachers had the chance, through the history of mathematics, to realise that "Patterns are the heart and soul of mathematics!" (Zazkis et al 2002, p.379)

