Chapter 8
Activities in the Secondary School:
An Arithmetic, Algebraic, Analytic path

ABSTRACT

In this chapter there is the presentation of a vertical path on the main topics of arithmetic-algebra-infinitesimal calculus and numerical methods, which are an object of study in the secondary school. Naturally, the attention will be focused on the "virtual" phase, that is the applications with the computer and the MatCos 3.X environment, both as graphical-numerical experimentation, of intuitive support to the understanding of the concepts, that as a necessary moment for the actual calculation in the applications. It presents a TLS based on a real problem, from which the whole presented methodology shines through: from problem solving, to mathematical and numerical modeling, to the formulation of the solving algorithm and its implementation in the MatCos 3.X environment.

... disregard for application and intuition leads to isolation and atrophy of mathematics … ~R. Courant, F. John (1965)

1. INTRODUCTION

In this chapter, in symmetry with the previous one, we will try to build a vertical path for the secondary school on the main topics of arithmetic, classical algebra, real functions and numerical methods. The methodology will be the one widely illustrated in the previous chapters and that is to say the constructive-algorithm-computational method will be privileged, in a problem-solving framework. In particular, we will focus more on the "virtual" or graphical-numerical experimentation phase, which is the real novelty of this book, widely justified by today's changed technological conditions. Of course, the MatCos 3.X

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programming environment will be used. The connection with the real world and, therefore, the mathematical modelling will be held in the utmost consideration, while taking into account the narrowness of the context.

2. ARITHMETIC

The concept of natural number and the related operations with execution algorithms are considered as having been acquired at the primary school, except for some reminders and further explanation where necessary, which the teacher will undertake. Just to test memories or see what has really been internalized, the teacher in the secondary school, at least in the first days of the school year, can resort to the playful aspect of Mathematics, to arouse interest and not indifference in young students. On the other hand, the high pedagogical value that can be recognized from the playful aspect has been reported several times (Gardner, 1987) (Ghersi, 1996) (Pappas, 1995). An example of this is the magic square.

2.1. Magic Square

The magic square is an object that is well known in the social sphere, for its high-level playful aspect, but also for its reference to art, appearing, as an engraving, in a painting by Albrecht Dürer (1471-1528). It is also a mathematical problem, not fully solved even today, but easy to understand, in the simplest formulation, by a large audience. The mathematical definition, in the most basic form, can be the one below. A magic square of order n, natural number greater than one, is a table formed by the first n^2 natural numbers, starting from one, arranged in n rows and n columns, so that the sum of the numbers contained in each row and each column and in the two diagonals are always be the same number, called the "magic" constant.

For example, a possible magic square of order 3 and magic number 15 is:

2 9 4
7 5 3
6 1 4

Obviously, there are others; it is enough, in fact, to invert the first and third lines and we have another magical square of order three. From a social point of view, interest arises from the fact that construction can be "the usual puzzle" that could measure "mathematical intelligence". But it also seems that in very remote times some esoteric meanings were attributed to some magic squares of a specific order. In fact, it seems that it was said that the magic square of order four could dispel feelings such as melancholy and sadness. In Dürer's painting 'Melencholie', a magic square of order four appears engraved on a wall. It is also mentioned in a beautiful dialogue of the film "Bianca" by the director Nanni Moretti (1953-).

From the mathematics point of view the main problems can be stated in the following way:

1) What is the value of the magic constant?
2) How can we construct a magic square of order $n>2$.
3) How many fixed-order magic squares are there?