Application developed for the Italian Ministry of National Education

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Introduction

The application we are going to present has been developed by FINSIEL in 1993 for the Italian Ministry of National Education, as a part of the project "Decision Support System" .

FINSIEL is the second-biggest software and computer-service group in Europe; it is state owned and has recently become part of STET, the state-owned telecommunications holding. Its main customers are the Central Government and Local Authorities (Ministry of the Treasury, Ministry of Education, Ministry of Health, etc....).
FINSIEL develops operational/accounting tools and decision support tools.

The application we are presenting forms part of the Decision Support System project that is being developed for the Ministry of Education by Finsiel .

The Italian school system is complex to analyse, because it has many and different components.

The school system is affected by many different social dynamics that cause a continuous evolution of the school service.

In particular, the necessity is pointed out by the working environment, to carry on education programs intended to increase the cultural quality of education, but the decreasing demographic trend should also be considered.

For this reason, a new training of the teaching staff is necessary as well as a new allocation of the available resources.

In this context, the decision maker needs suitable instruments, belonging to the class of Decision Support Systems (DSS), to compare different scenarios both in the future and in the present, besides ordinary operational tools.

The main structure elements of the DSS will be:

- A historic data base which stores information at high level of synthesis;
- a system to make queries to a relational data base that makes the user free from all problems involved in data access;
- a system to describe social phenomena by indicators defined at different levels of detail
- a school system integrated model.

The data base supplies most of the data other systems need.

The model provides the forecast of the chief elements belonged to the school system and also allows to simulate and evaluate normative and behavioural variations.

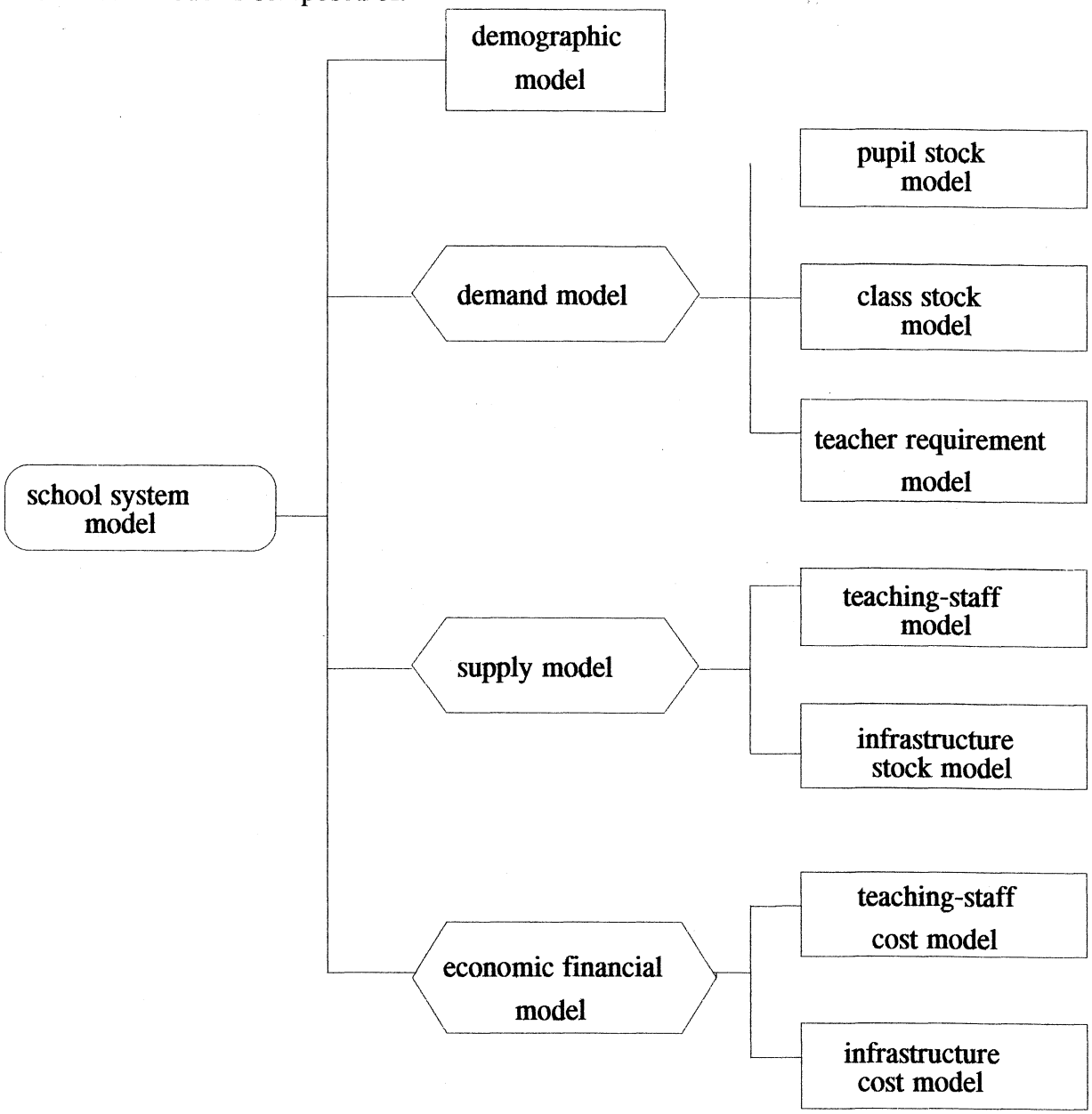
The school system model

The goal of this model is to provide an ordered and systematic global outlook of the present situation, the dynamics of events and the links connecting the different variables of the school system.

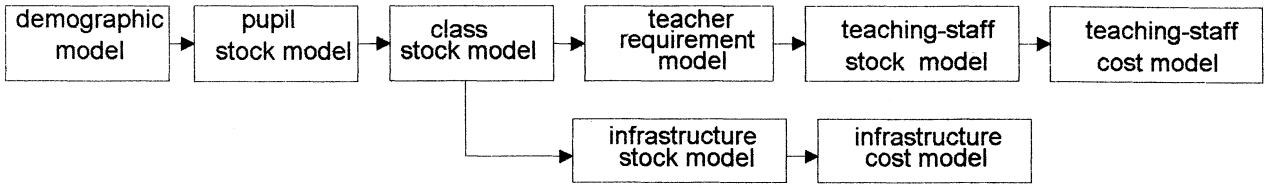
The model will be a support automatic tool in the decisional phase to compare different scenarios in the future, evaluate direct and indirect results coming from different choices and show outputs.

The software product is a part of a broader model, still in the development phase, which will provide the decision makers at the Ministry with forecasts of all the major quantitative variables of interest (number of students, classes, teachers availability, costs, etc.).

The broader model is composed of:



The model logical sequence is:



The whole model will be developed in SAS® software. This choice is due to the product capacity and flexibility.
Each model has, in fact, peculiar characteristics involving the use of various procedures and tasks according to the requirements, besides the data step and macro language.

The student model uses both the SAS/IML® and the SAS/ETS®.
The class model (that is a group of students attending the same course) uses regression procedures.

The teacher requirement model is composed of three sub models related with the three school degrees[1]:
- primary school;
- secondary school (from 11 to 13 years);
- secondary school (from 14 to 18 years);

The primary school model uses the SAS/ETS®.
The other models use the SAS/IML® and the SAS/SQL-DS™.

The whole model system runs now on Personal Computer, but, in the future, it will be run on departmental systems.

The secondary school (from 14 to 18 years) teacher requirement model.

The secondary school (14-18 years) is split into four different kinds of instruction:
- humanistic,
- technical,
- professional,
- artistic.

The duration of the course is variable: from 3 to 5 years. It is necessary to frequent a 5 years course to have access to the University.

Over the last few years specialised subjects were introduced (for example: computer science, business administration, civil law, etc.) in the secondary school (14-18 years). As a consequence, different kinds of branches were created within the same instruction courses (humanistic, technical, professional, artistic).
Each branch consists of a group of subjects and a plan of studies.

The great number of these branches brought about a very fragmentary and not manageable situation. For this reason the Decision Maker needs to rationalize the secondary school organization.
This fact comes from the necessity to compare the teaching requirements with the teachers stock for each subject.
In fact, qualified teachers are few despite the general surplus of teachers as regards the real needs.
For this purpose, we have developed an instrument that enables the Decision maker to advance alternative hypotheses to reform the secondary school plan of studies and evaluate the effects (over 5 years) on the needs of the teaching requirements for each subject.

The implementation of this model is based on the analysis made in collaboration with the Ministry of Education.
This analysis intends to identify the branches that have really different plans of studies (leader branches).
Only for these leader branches we forecast the registrations for the first year of the course; for all the others branches existing in the last year for which we have definite data we forecast only the following years until the end of the course of study.
The forecast algorithm for the teaching requirement is based on the estimate of the amount of the teaching hours in the week related to each subject. This estimate is divided by the average number of the weekly teaching hours related to the same subject.

The algorithm may be represented by:

$$catt(jpyt) = \frac{ore(jpyt)}{ormed(jpyt)} * \frac{ormed(jpy0)}{oreff(jpy0)}$$

where

j = subject
p = province
y = kind of instruction
t = school year
0 = last year for which we have definite data

catt(jpyt) = the teaching requirement forecast related to the subject j, the province p, the kind of instruction y, and the school year t;

ore(jpyt) = the amount of the teaching hours in the week related to the subject j, the province p, the kind of instruction y, and the school year t;

ormed(jpyt) = the teaching hours average number during a week related to the subject j, the province p, the kind of instruction y, and the school year t;

ormed(jpy0) = the teaching hours average number during a week related to the subject j, the province p, the kind of instruction y, and the school year 0;

oreff(jpy0) = the teaching hours effective number during a week related to the subject j, the province p, the kind of instruction y, and the school year 0.

The forecast of the amount of teaching hours is calculated with this algorithm:

$$\mathbf{ore\ (jpyt) = \sum_{x,i}\ (\ class\ (\ xyipt)\ *\ pianore\ (\ jxyit\ )\ )}$$

where

x = branch
i = year of the course of study (first, second, third, etc.)

class(xyipt) = number of classes that attend the branch x of the kind of instruction y for the year of the course of study i in the province p and the school year t;

pianore(jxyit) = plan of studies of the branch x of the kind of instruction y for the year of the course of study i in the province p and the school year t.

We faced several theoretic and technical problems that we solved using SAS® software.
The first one was to link the output of the class stock model with the teaching requirement model.
The class stock model makes a forecast for the kind of instruction and not for the branches involved.

This is necessary in order to relate the number of classes with the teaching hours of one subject in a given branch. We applied to all branches belonging to a kind of

instruction the rates of passage from one year to the following one and from one course year to the following one, as from the class model.
These passage rates were accounted by SAS/IML®, given the matrix nature of data from the class model. This permitted to get a forecast of classes for both course year and branch.
The second issue was to relate this result with the subject time schedule for each branch. We had two data sets for each branch and we wanted to relate all records of the first set, representing a given key, with all records of the second set, having the same key.

For example: given dat1 dat2 we wanted to get dat3

dat1	dat2	dat3
A 1 2	A a	A 1 2 a
A 2 3	A b	A 1 2 b
B 5 6	B b	A 2 3 a
		A 2 3 b
		B 5 6 b

To this purpose we used SAS/SQL-DS™.

Given the high number of provinces and branches for each province, this implies the creation of data matrices of over 70,000 lines and 30 columns requiring a powerful and quick accounting device.

The parameters that the user may change to investigate for alternative scenarios are two:

1) percentage of applications to one leading branch;
2) study plans.

With the first type of parameter the user may vary the distribution of applications among the different branches, and insert or delete branches.

With the second type of parameter it is possible to vary the teaching hours of one subject in a given branch, insert a study plan for a new branch, delete or add new subject to a branch.

Both parameters have matrix form and are stored as DBF files.

The interface was made with EXCEL to maintain a standard graphic with other components of the Decision Support System.

By SAS/ACCESS® a view of such files was created so as to permit a user-system dialogue.

NOTE:

SAS software, SAS/IML, SAS/ETS are registered trademark and SAS/SQL-DS is a trademark of SAS Institute Inc., Cary, NC, USA.

[1]The primary and secondary schools (from 11 to 13 years) belong to the compulsory education. The course of study lasts 8 years: from 6 to 13 years.