S.C.A.C.CO.[1]
An Expert System for Financial Accounting Teaching

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[1] Acronym for "Computerized System for the Learning of Accountancy Circuits", meaning in Italian "chess".

Abstract

From Luca Paciolo Abaco Era to modern ERP, accounting teachings methods are not really changed at all. In fact, students have to learn a group of Accounting rules which are not always organized in systematic way.

The aim of the paper is to show the main technical characteristics and the impact on students' performances of an expert system, programmed by the author in Visual Lansa, for formalizing and supporting Financial Accounting learning process.

The expert system "Scacco®" simulates, step by step, the systematic logic process every student has to follow in order to solve:

1) bookkeeping and accounting system problems;

2) annual report (balance sheets and income statement) "building" problems.

From the System Dynamics point of view, Scacco is a systematic model which, on one hand, represents firm operations and, on the other hand, is based on "try and correct" feed-back mechanism.

The Scacco ® software has just been tested in the Financial Accounting course of the University of Salerno. The software has led to a remarkable improvement in students' performance.

1. Introduction

In Italy, during the academic year 2001-2002 the University structure reform has been gradually carried out (the so-called 3+2), as provided by law, by deeply innovating syllabuses structure and teachers architecture by introducing for the first time in Italy the Credits System (CFU).

Financial Accounting teaching thus requires a considerable *reengineering* process regarding training objectives, contents to be included in Syllabuses, didactic technics to be adopted, learning testing criteria.

The courses gradually introduce the student to the solution of problems of accounting, with particular reference to Bookkeeping and Balance Sheet drawing.

Today a radical re-thinking of "traditional" didactic instruments is enforced by many events: the modular logics ispiring the Reform; the numerous solutions proposed by Italian Faculties on how articulate the teaching of subjects dedicated to financial accounting; the change of the firm; the training standards that firms management expect from University graduates.

2. *IT support application to Management and Accountancy didactic in Italy*

During the last years in Italy two phenomena have been imposing to the attention of management and accountancy scholars:

- the gradual, unbreakable change of the object of research, its borders, its relations with the environment;
- the evolution of the way of producing, organizing, communicating, learning knowledges, in and out of the firm (Ferraris Franceschi, 1998).

Both phenomena solicit a re-thinking of management and accountancy teaching objectives, contents, methods.

It appears of particular importance, thus, the introduction or the widening of IT use in support of didactic, especially academic one.

In the evolution process that brought Italy in the 80s-90s to concrete operative actions in the field of Management or Accountancy academic teaching, a cycle of development of IT applications to the solution of didactic problems can be noted. We can isolate three phases conventionally definable:

- "pioneeristic phase";
- "a-systematic phase";
- "mature phase".

Each phase appears characterized essentially by:

- the level of the student basic knowledge;
- the friendly use of the IT tools employed;

- the didactic objectives effectively pursued.

In the "pioneeristic phase", (around the 80s), the diffusion of the Personal Computer within Italian households is limited: electronics big companies are just experimenting the first processors; the product is rather "expensive", private users market seems not to be much attractive (Barile, 1995). Students do not know the functioning and potential of PC and its introduction in university courses is a revolutionary event, independently from the contents and the abilities the PC allows to trasmit. It therefore "attracts" the attention and seems to gain an euristic scope, independently from the context in which it is inserted. Innovator teachers are thus in the position to perform as trainers, first of all: *user-friendly* programmes are rarely diffused, due to bonds of time and available resourses; IT applications are limited to the solution of particular problems; they are directed by the teacher or confined to game-playing, well known by teenegers (for example Amiga, Commodore 64); finally, thy are used especially in marketing and strategy advanced courses (Eminente, 1981).

The "a-systemic phase" extends to the first half of 90s. This is a phase of strong development of PC on the private user market segment. The simpler applications, as *wordprocessor* and *spreedsheet*, begin to be "attended" by an increasing mass of people. Thus, whoever is intentioned to introduce an IT tool in university courses needs only partially to face the problem of students training. In any case, PC is no more considered a "myth of progress", but a work instrument: attention is mainly concentrated on the objectives, the structure, the communicative potentialities of the IT support. Consequently, also the students' critical capacity increases. In this phase teachers innovative energies are oriented mainly in three directions:

- adoption of analysis instruments of the firm sub-system functioning (Bussolin, 1990; Panti, 1990);
- the construction of economic-financial models, such as balance sheet or budget (Favotto, 1985; Marchi- Paolini-Quagli, 1997; Saita, 1996);
- the execution of guided exercises through tools such as the S.A.DI.CO. software (Marchi – Ciaramella, 1994; Quagli, 1995).

In this phase the objective is to emphasize the active role of the student, who is asked to learn and reproduce the acquired knowledge by interacting with the IT tool. The level of complexity of the software used is still relatively low (spreadsheet and Visual-Basic are in fact the programmes and languages adopted). The applicative developments are still mainly devoted to the reporting of quantitative aspects.

In the "mature phase", that is the current one, PC represents one of the most used commodities in the Italian households; young people have a basic IT culture, independently developed when still very young. IT products are powerful, quick, reliable, and allows graphic, textual and algorithmic, musical, informative functions, etc. Finally, it is to be highlighted the role of the Internet and of *software* allowing access to the Internet (Zavani, 1997). The professionalities requested by firms must include in their own expertise "Basic IT knowledge" (AA.VV., 1998) and "IT management of enterprise data" (Marchi – Mancini, 1999) which become subjects regularly taught in Economy Faculties. All this does not seem to be sufficient, though.

Many teachers of management and accounting subjects feel the necessity of introducing in their courses advanced and personalized IT supports. Also the technologies used appear to be much more complex and flexible than those of earlier periods. W*eb sites* are more and more used to allocate information, didactic material, exercises to be executed, download *software*. "Traditional products" as the budget are revised (Antonelli – Cerbioni, 2000): Internet Explorer becomes the interface, multimedia language is used, the support consists of several parts inter-connected by hypertextual *links*; from *floppy-disk* to CD-ROM. Models based on the "*System Dynamics*" are developed for the analysis of small enterprises development conditions per "external lines" (Bianchi, 1996; 2000; Mollona, 2000).

In the current phase, IT applications in the didactic appear less and less limited to exclusively quantitative based models or procedures, useful for the solution of particular economic-entrepreneurial problems; they remain under the teacher's control in the software planning phase or in the results testing and assessment phase, they are integrated in the teaching

course through the development of specific learning aspects and routes, but they do not substitute the basic didactic structure. However, the aspect of rigidity, due to the technological structure adopted or the hypothesis pertaining to the software functioning and logic, appears to be overcome, though not completely sorted out (Antonelli, 1997).

3. *S.C.A.C.CO. and its use in Financial Accounting teaching*

The student should be offered an observation perspective of the enterprise phenomenon, which highlights its systemic structure and its continuing evolution in a more ample social, juridical, economic context, even when the objectives of the models construction are of a didactic kind.

To this purpose, in order to have the student concentrate on the enterprise systematic point of view, it is necessary to analyse both the relation between the former and the production unit, from which it has been isolated for didactic purposes, and the relations between the latter and the environment in which it lives and operates.

If we proceed in the construction of didactic models aimed to favour the learning of the structure and the functioning of the enterprise sub-systems, a sytemic vision that from the "particular" always reconducts the student to think of the "general", is useful.

Several are the possible solutions, if we want to formalize the logic scheme. This should be first of all followed by an expert enquirer, so that any management operation is converted in account values. The aim is to reach a complete and onmicomprehensive sequence of instructions to be given to the *software* with which the human though reasoning is simulated. This is testified by the more and more varied operative procedures available on the market of administrative-management *software*.

From the didactic point of view, the needs pursued are obviously different.

First of all, it is possible to project the *software,* so as not be obliged to run variables connected to the "context conditions" in which Financial Accounting is actually kept. It is thus possible to "eliminate" elements such as the registration progressive number, the reference to the original document, the operation description, the necessity to print periodically the registrations, the input of VAT codes, or the necessity of costs and profits reclassification aimed to management control. These semplifications are undoubtly useful since they allow to limit the number of variables run by the person charged with registration and have him concentrate on registrations more conceptually demanding. However, it is to be considered the fact that also other data assume relevance, if the enquirer were in front of a computer of a real IT system and should enter these data, in the presence of integrated systems as those that find everyday increasing diffusion in enterprises. Such systems, furthermore, are based on the uniqueness of the data input process and presume security and competence in finding all the aspects of a management operation, including those not influencing directly the dynamics of economic-financial values.

Secondly, the aim is to ensure student be faced by *problem-solving* (the correct registration of a management operation) and that he offers a solution responding simultaneously to two validation criteria:

- the result is correct;
- the logic route to find the result is correct.

In case the student offers the correct solution at the first attempt, no machine is able to test the mental, deductive, mnemonic process he followed, unless he is requested *ex-post* to explicitate it. On the contrary, in case the student offers a solution moves away from the one the *software* is provided with, the latter can verify the "shifting rate" and suggest a route structured upon a hierarchy of logical phases chosen by the programmer for the research of the correct solution. Needless to say that each possible segment of logical phases reflects the theorical conception elaborated upon *software* programming.

S.C.A.C.CO. (Computerized System for the Learning of Accountancy & Bookkeeping Circuits) is a multimedia *software* programmed on Visual Lansa language gathering numerous applications.

The main aim of S.C.A.C.CO. is to offer an integrated and complete instrument to allow the student to exercise his own knowledge and abilities in the solution of principal registration problems.

S.C.A.C.CO. is currently structured in two basic modules:

- general accountancy;
- Balance Sheet.

S.C.A.C.C.O. appears to be particularly flexible and decomposable to attain specific and delimited didactic objectives, according to a logic of integrated programming of contents and didactic methods.

S.C.A.C.CO. appears as an instrument prizing the significant learning and the discovery learning: in fact, it requires the continuous reorganization of the knowledge relevant to the registration of the single operation within the structure of the firm; moreover, though with some limits, it allows the student to explore possible solutions, at least whenever solutions are not completely rigid. This instrument, however, must not be confused with the decisional and operative process, which prearranges, carries out and verifies the information and knwledge acquisition activity by the student.

S.C.A.C.CO. is a didactic application useful for the formalization of the knowledge and for the verification in the objective sense, that is, it is focused on the results of the individual learning.

The didactic objectives pursuable through S.C.A.C.CO. are:

- learning general accountancy and balance sheet technique;
- acquisition of an "IT perspective" through which observe registration problems, in a context which, though extremely simplified, is aimed to reproduce the firm context;
- conceiving the posing of a problem and the search for its solutions, not in absence of information, as usually happens in the didactic field, but on the contrary, exactly as it happens in the firm, counting on numerous *"help"* (those to which professional diligency imposes every time the consultant, the administrative manager, the enquirer do not know the solution *"in default"*: accounting principles, civil and fiscal rules, existing enterprise documentation, and so on);
- inter-connect the "modules" in a systematic perspective, as obviously do the E.R.P., or others administrative integrated systems, which the student will find in the firm.

The didactic objective will have to be always oriented to the creation of critic knowledge, paying attention above all to the interpretation of evolutive phenomena, that is sensitive to change, complex, able to connect the object of the research in its time-space coordinates to the system it is inserted in.

The use of an IT support implies, thus, the clear individuation and personalization of the didactic action model to which the perfomance of this *software* better adapt. To this regard, it is possible to distinguish three logical moments:

1 – didactic programming, concerning the choice of the objectives intended to be pursued, up to the rational articulation of the subjects and the modalities of introduction of the IT support within the course;

2 - implementation of the didactic activity: choice of the teacher responsible for the course, use of the available structures, work organization with the students, etc.;

3 – testing of the didactic action, referring to measures of *customer-oriented* e *learning-oriented performance.*

IT application alone, however, can be sufficient. It presents several limits: reduction of complexity, limitated options, absence of a critical element. It thus find in the interaction teacher-student, still today impossible to substitute, a natural completion.

S.C.A.C.CO. *software* technological potentialities have to be fully valorized; in any case, limits to concepts formalization and quantitification and the complexity of enterpise phenomenon will have to be taken into account.

As discussed it appears clear that the introduction of S.C.A.C.CO. in the didactic presumes the preliminary solution of multiple issues.

The contents this application is useful to must be organized and be systematic, new and progressive in the development and exposition.

Through this instrument it is possible to target general and particular didactic objectives, which however have to be defined in terms of competence, ability, attitude.

The human learning process that it is possible to activate with the *software* must be consciously chosen. It is to define which objectives of discovery, reception, production, organization or use of enterprise-economic knowledge we intend to valorize. The *software* contribution to learning and self-evaluation through an unstructured route of interaction, must be observable and measurable. Finally, coherence with the overall didactic scenary must be ensured, that is the method adopted in the complex, together with the other technics in use in the academic course or in the general training sytem of economic faculties.

The university structure reform, previously mentioned, oriented towards the training credits system. The chosen model has several effects on the academic organization. The main effect is to deeply affect the didactic action model, that is it influences:

- the training objectives;
- the activities of transmission and acquisition of knowledge and ability;
- evaluation criteria of the learning Δ.

The didactic action model, emerging from the credit system in criteria of programming, management and control of didactic processes, seems inspired, therefore, by the following criteria:

- contents modularity;
- problems sequentiality;
- possibility of learning grade assessment and comparability, in time and space.

S.C.A.C.CO. is aimed to respond to such criteria.

The contents are modular in that the *software* allows various subsystems it is possible to access separately from one another. Inside each of them, we can then delimitate a specific learning route.

The problems faced are afterwards organized in a logic scheme of a sequencial type, described in paragraph 2.

Finally, for each section an evaluation methodology is offered, considering both the contents and the timing of the single activities and, therefore, cumulatively it allows to calculate the overall time "used" by the student in front of the computer.

Obviously S.C.A.C.CO. does not allow to solve all the problems created by the reform. In fact, its introduction depends preliminarily by the individuation of the student's knowledge *background*, the teacher's capabilities, the contents we want to trasmit. In some universities it also depends by the availability of feasible *hardware resources.*

In conclusion, the partial innovation introduced with S.C.A.C.CO. inscribes in a new didactic perspective, which long term effects are in any case unforeeable.

4. S.C.A.C.CO.: the I.T. model

The development of a didactic model of financial accounting implies the maintainance of the functioning principles of this registration instrument.

The following described model is formal one; in order to communicate with the electronic elaborator, the knowledge in all its sintactic, semantic and pragmatic aspects necessarily was to be coded.

At sintactic level, the software was provided with the rules with which lessical elements are combined to create complex lexical constructions[2]; at semantic level, operations were carried out on the lexical constructions by attributing a precise and univocal to the accounts[3]; at pragmatic level, finally, the attitude that a certain linguistic construction should induce on the addressee, that is the student, was focused on.

The developed model is, moreover, abstract in that it does not consider the mass of details of which operations must leave track in the information systems; however, it has to find the aspects generalizable to all the classes of enterprises in terms of elements and relations among

[2] Ex. the software was taught that a costruct similar to "Merci c/acquisti a Fornitori" is correct, whereas the use of a construct like " Fornitori a Banca a Cassa " is not correct.

[3] Ex. the software is taught to understand that a registration like "Merci c/acquisti a Fornitore 20.000 Euro" is to be interpreted as debting on Merci c/acquisti e and crediting on Fornitori for the amount of 20.000 Euro.

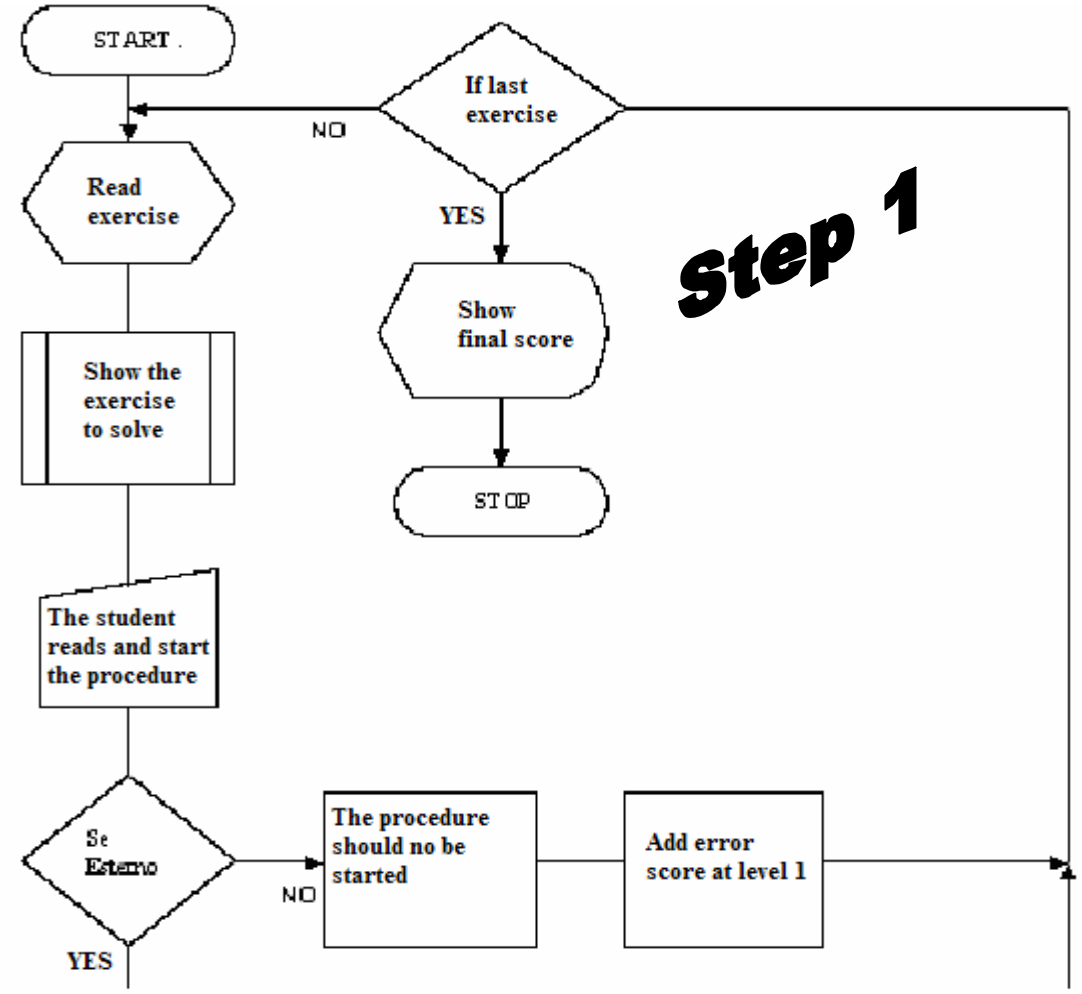
them; it has to be synthetic, in that it has to take into account only the aspects considered useful for the aims of model creation; it has to be structured because the real system is represented as important units and by subsystems, connected among them; it has to be significant because from the exam of the model, it is possible to logically infer knowledge not explicitly represented; it has to be interactive, in that it allows an immediate response (confirmation/correction) to the student's activity (Marchi –Mancini, 1999).

The model in consideration can be examined under a double aspect of observation:

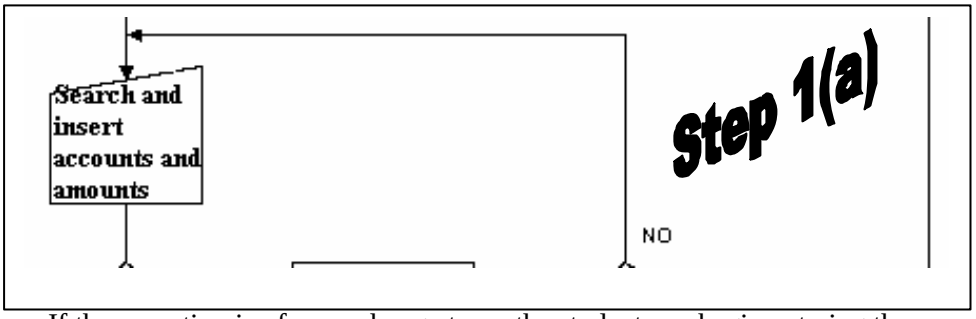
- structural;
- operative.

4.1. The structure of Scacco

The model structure is formed by a knowledge basis consisting of a series of elements and relevant characteristics inter-connected by several rules-relations. The elements are the single accounts; the relations are the accounts characteristics. A complex object, the "extended account" is created; it contains a considerable series of attributes which allows to teach in an indirect manner, compared to the Partita Doppia functioning rules applied to the Sistema del Reddito and of the Capitale. The reference model can be synthesized in the following flow-chart (subdivided into steps):



In the first step, as highlighted in the paragraph 2.1., the model checks that the exercise proposed to the student be an external management exercise. It is only in this case that the student begins the operations described in the following pages.



If the operation is of an exchange type, the student can begin entering the accounts he reckons correct for the accounting registration proposed.

The insertion of the accounts can take place through two proceedings:

- First proceeding: *group of accounts*;
- Second proceeding: *single accounts*.

The first proceeding carries out a double function.

First of all, it allows to reduce the variety of accounts usable in relation to the operation proposed.

In this way, it is possible to select only the group of accounts that will presumably offer major guarantees for a correct representation of the operation.

This function is very important for the user in that he can use a predefined scheme from which he can select step by step the single accounts as necessary, instead of being completely free in labelling them.

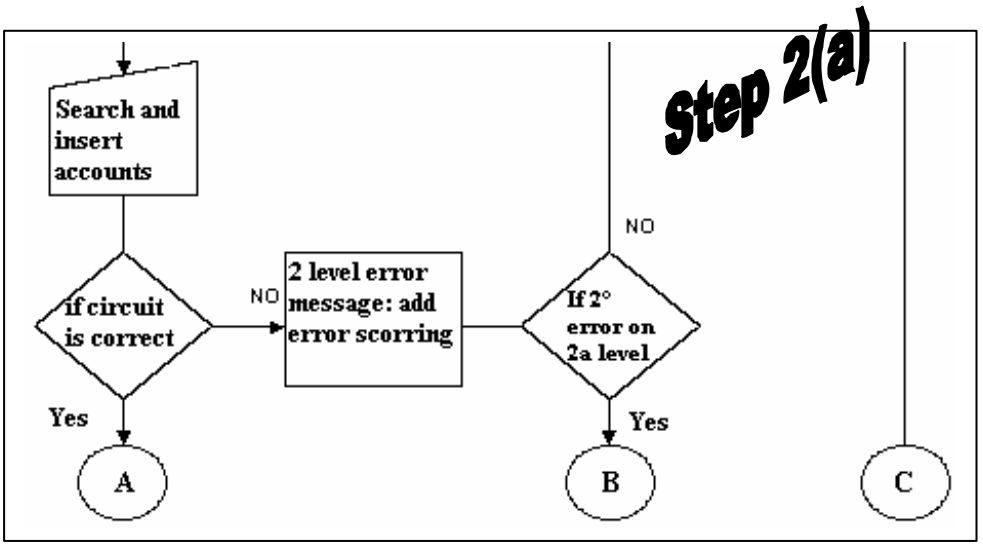
The second function of the group of accounts is connected to the category of the groups of accounts themselves.

The groups of accounts presented in the programme, in fact, represent a considerable approximation to the structure of the Annual Report as defined by Law (Balance Sheet, art. 2424 civil code, and Profit and Loss Account, art. 2425 civil code).

In this manner, the user may acquire familiarity not only with the typical structure of the Annual Report, as enforced by law, but he may reflect immediately on the destination of the values involved in the single operations.

Once concluded the first research and entering proceeding, the second proceeding can be considered. As decribed in the third chapter, it has been decided to allow research per single word of the account, since such a condition approaches the model to operative reality, where registrations are carried out on the base of a pre-defined plan of accounts.

The system then analyses the appropriateness of the accounts used to the reference circuit of the exercise proposed, after the user has chosen the account based on the proceedings described in the instructions.



In case the student is not capable of performing the accounting registration of the operation, because he cannot find out its nature (for example, he continues registering the subscription of Capital as a purchase operation), obviously he does not need to "work" on the accounting aspect, but on the analysis of operations. The *software*, thus, suggests preliminarily if the accounts used for the solution are or are not pertaining to the circuit to which the operation can be assimilated. Only when the student has inserted one or more accounts relevant to the "correct" circuit, the *software* does not give the autocorrective message, "*the operation is correct when insert into circuit of ...*", anymore and moves to the next step.

Once the circuit has been identified, the accounts at the student's disposal must be obviously reduced to the only ones useful to representation of that class of operations. Tehrefore, accounts pertaining to other circuits (*n* - 1) are "darkened" in the plan of accounts.

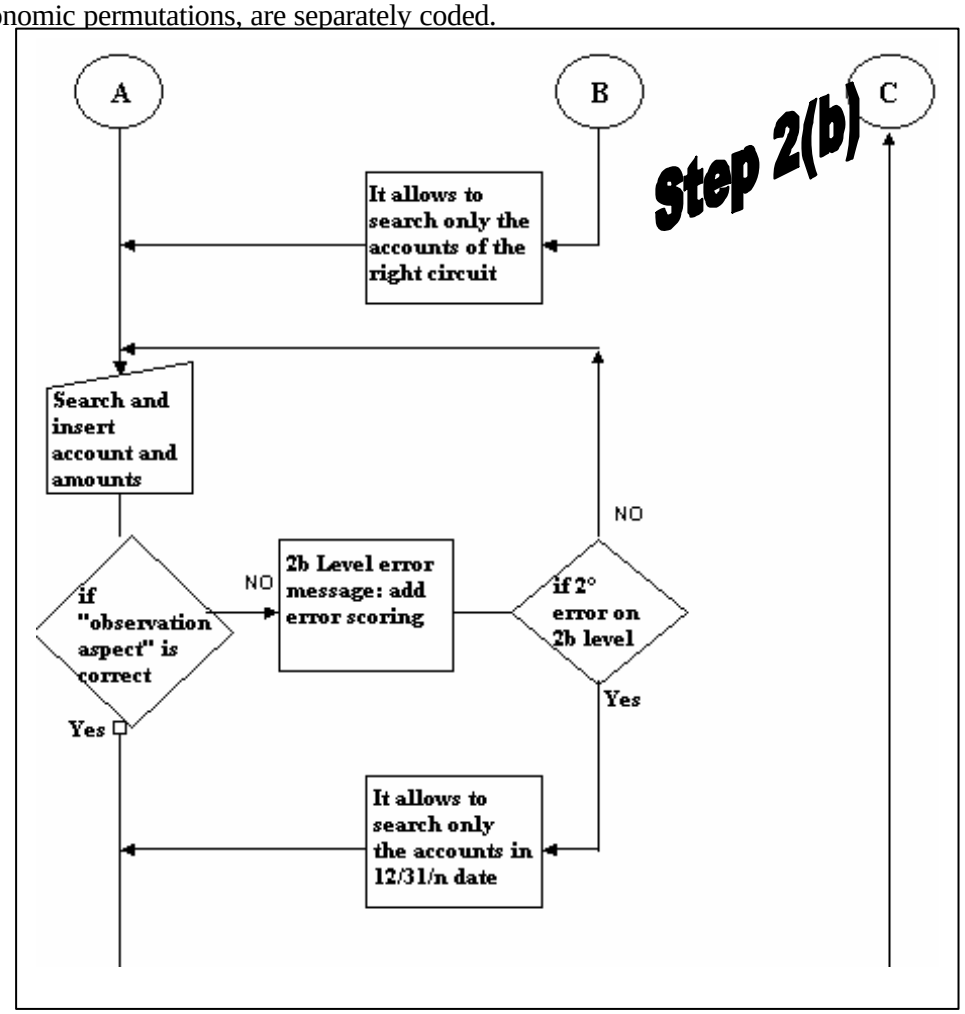
At this point, the student must find the original and derived observation aspect. Preliminarily he must establish whether the operation is registered during the administrative period or upon the determination of the Income. In the first case, in fact, the original aspect is numeric or, as generally accepted, financial; on the contrary, in the second, it is the economic aspect.

It is in this level that the software analyses the solution to compare the scheme with that of permutations.

It will consequently search for the original aspect in:

- *economic-financial* permutations;
- *mixed* permutations;
- *financial* permutations.

Continuing operations, especially those of the Share Capital circuit, which generate only economic permutations, are separately coded.



After having correctly found the aspects of observation, the student must preliminarily establish in which permutation scheme he has to find the answer to the text of the exercise.

This step has a considerable information capacity since it allows to correct the student's conceptual scheme, which could also be uncongruous with the operation to be analysed.

The student will have then to decide if the operation generates financial and economic variations, positive or negative.

Such a choice is oriented in a double direction:

1 – the student can access only to the accounts having reference to the circuit previously found;

2 – the financial values are distinguished in certain numeral values, assimilated, assumed and financing credits/debts; whereas the economic values are distinguished in active / passive values of patrimony, pending costs / profits; pluri-annual costs / profits, yearly costs / profits. The *software* signals to which of these classes the accounts to be used must belong to.

The system shows the student a prospect similar to that of modern administrative systems in which the user can enter the chosen accounts.

It is the system's internal logical mechanism that transforms the bi-sectional prospect containing the accounts chosen in a quadrant scheme of the decribed type.

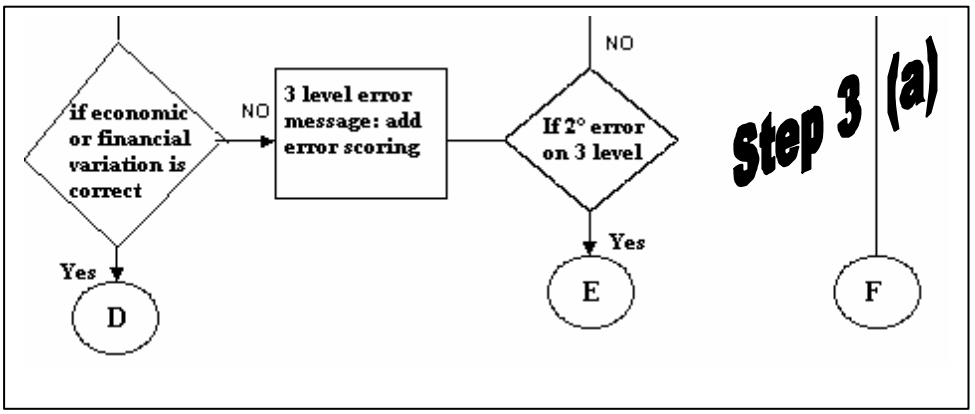
This logical transformation is possibile thanks to the following correspondence:

(FINANCIAL / ECONOMIC) VARIATION

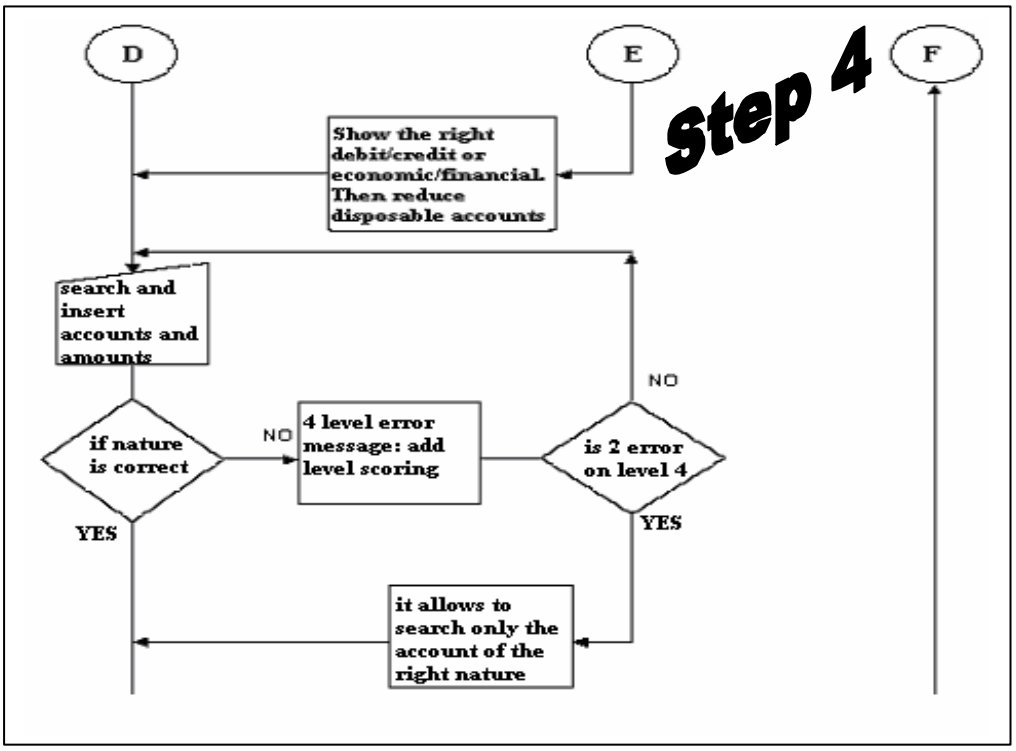
NATURE OF THE ACCOUNT

ACCOUNT

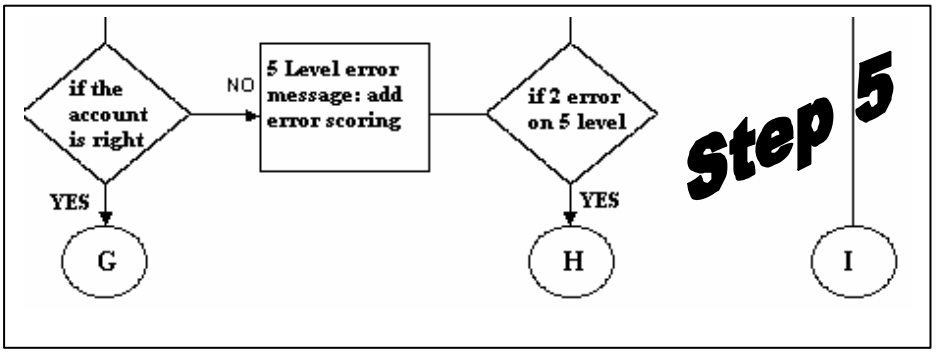
The System in fact steps back from the single account (ex. "Cash and bank") to the nature of the account itself, and, through the third correspondence, it associates the type of the chosen account to its nature (in the example, "financial type").



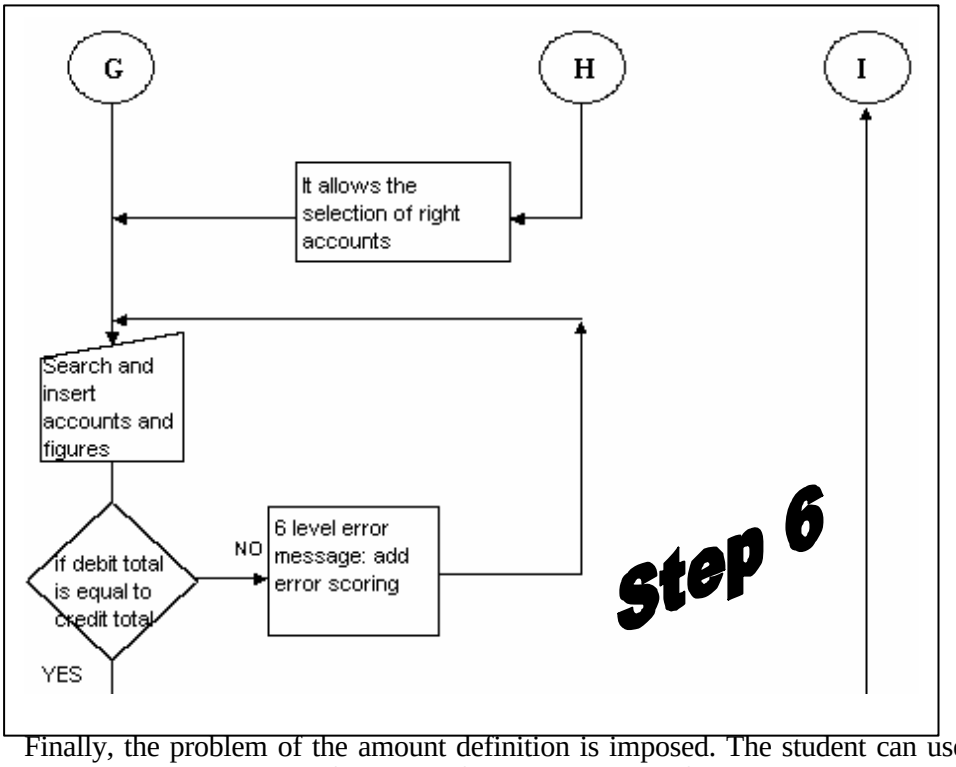
In this step, the model compares the answer given by the user to the permutation scheme and to the nature of the variations within the scheme.



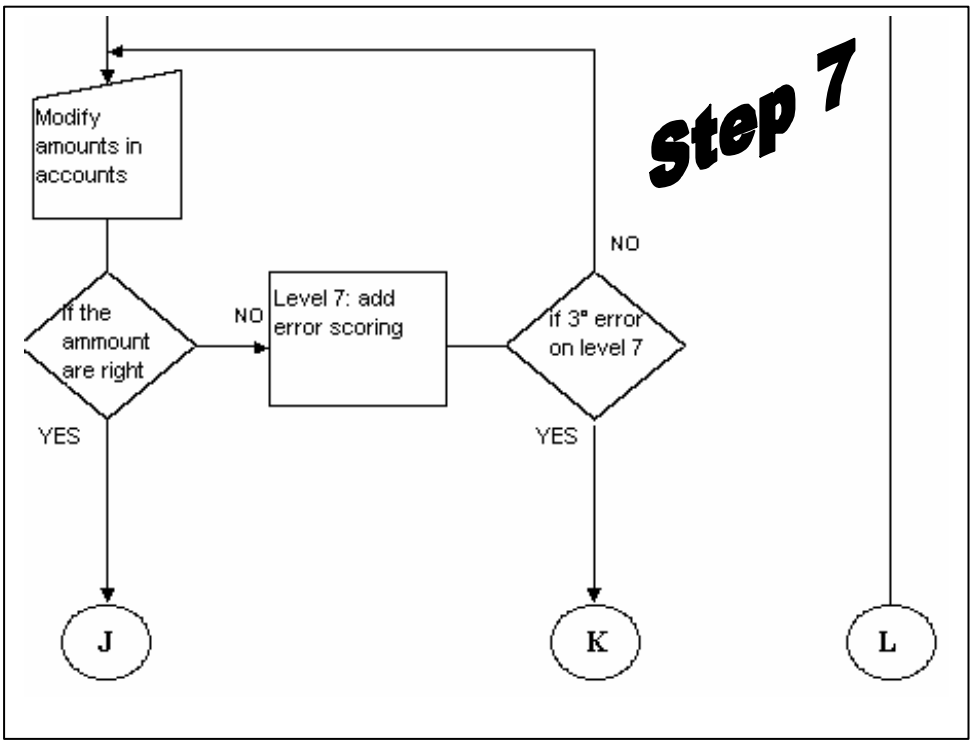
At this step, the final comparison between the accounts proposed by the user and those provided by the solution is to be to executed.



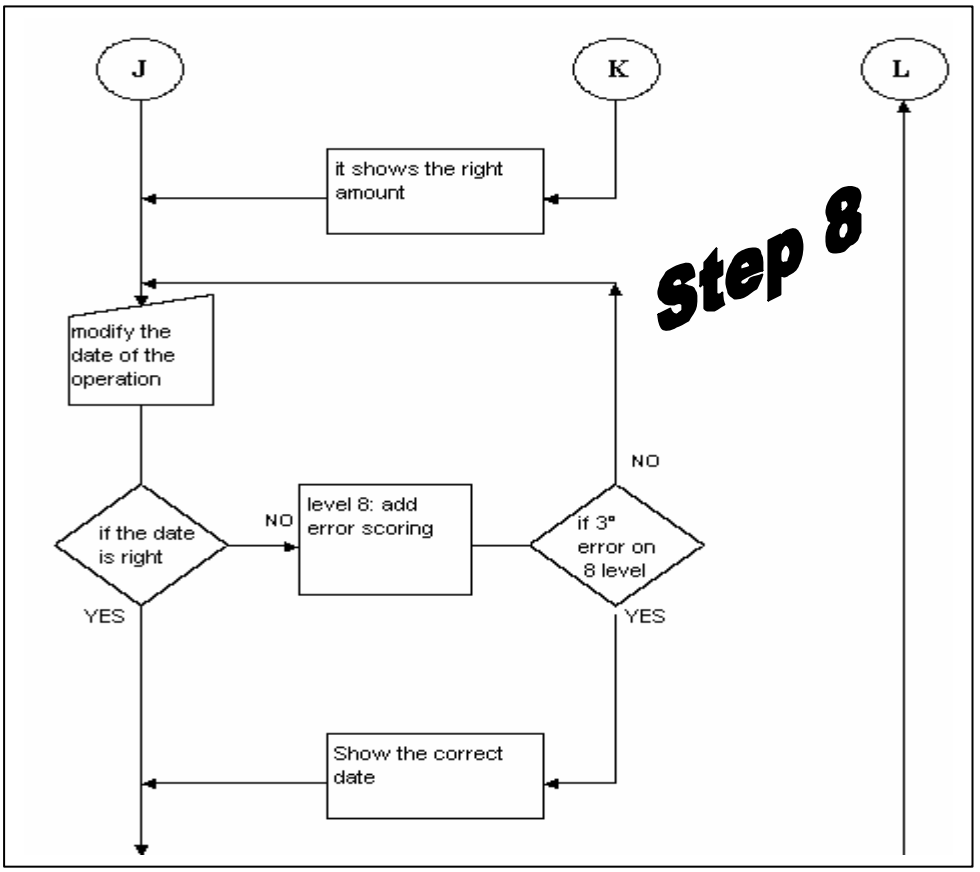
Being certain of the correcteness of the accounts entered, the balancing of the sections "*debit*" and "*credit*" is to be verified.



Finally, the problem of the amount definition is imposed. The student can use a calculator and a calendar, above all. Afterwards, for some classes of operations (purchases and sales of goods and services, acquisition of professional services, etc.) motivation of occurring calculation errors is also given.



It is only to be verified if the user has understood the moment in which the registration is to be correctly carried out.



S.C.A.C.CO. evaluate, thus, the route the student has followed to reach to the correct solution, "weighing" the errors and registering the time used to find such a solution.

4.2. The module "accounting registrations"

The operation of the model develops along the two proceedings following described.

The teacher establishes first of all the exercises to be introduced, by proposing per each one of them the answer considered correct in terms of timing , scheme of the operation, nature of the accounts, denomination of the accounts, VAT code, by using the prospect similar to the "prima nota" of any professional management software.

Having the user proposed his solution, the to chosen exercise, the model functions following the *steps* described in the previous paragraph.

The model, however, does not compare directly the accounts of the solution proposed to the accounts of the model-aswer; it firstly steps back to their general characteristics (internal or external operations, correctness of the circuits used, nature, type) and highlights the occurring dicrepancies; afterwards it procedes to the exam of the other characteristics, less and less important, signalling with appropriate messagges, the kind of error made.

In other words, further to the request for correction given by the user, the model operates on the solution proposed, firstly recognizing the “characters” of the student’s answer, secondly the “characters” of the solution entered by the teacher. On the basis of difformities of the former compared to the latter, error signals emerge, if it is the case.

The check-ups operated can be listed in three main classes:

REPRESENTATION ERRORS
(Step 1 to 5)

QUANTIFICATION ERRORS
(Step 6 to 7)

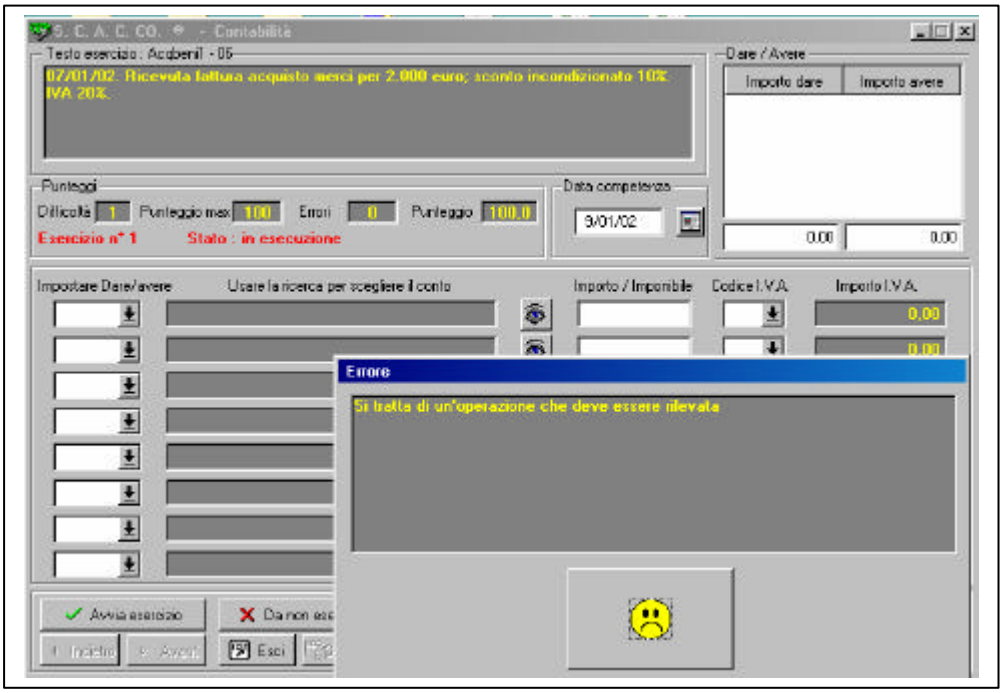
TIMING ERRORS
(Step 8)

Supposing the user is to register the following operation «We received a charge for a raw material purchase *2.000 €; discount 10%, VAT 20%* . Let us follow the various error messagges.

Step 1

According to the user, the operation must not be registered since it is not an exhange.

S.c.a.c.co. prompt the following message:

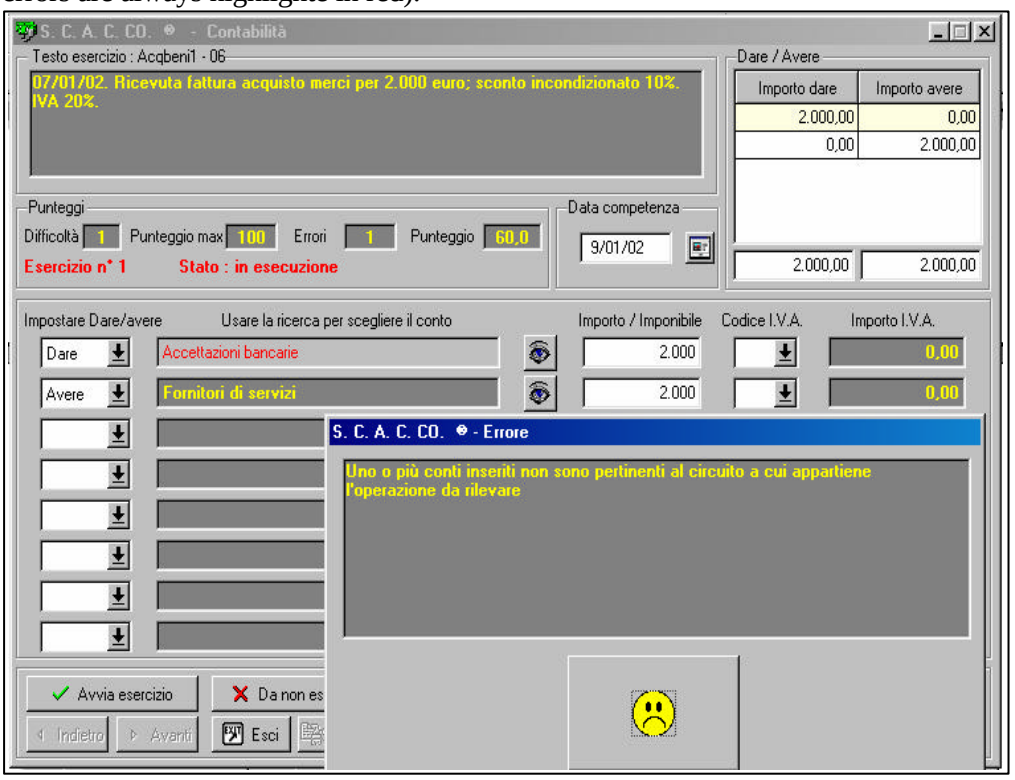


Step 2a

At this point the user can understand that it is an external operation, and therefore it has to be registered.

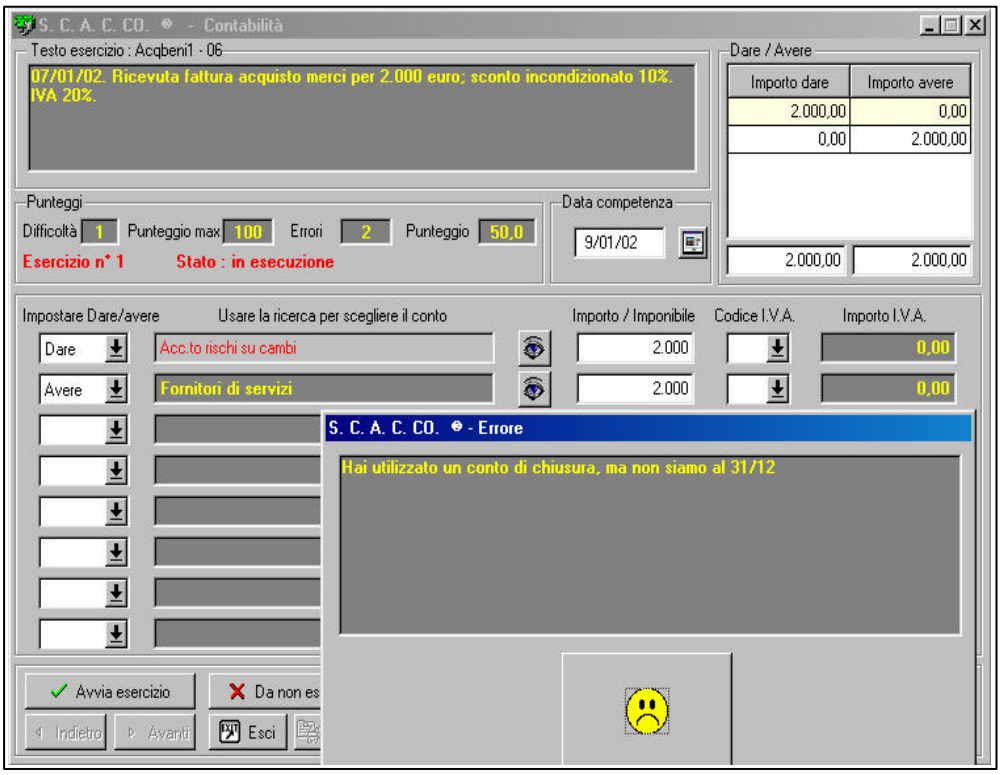
He chooses then the account to be entered in “Debit” and “Credit”.

After that the user chooses the accounts, the system analyses their pertainance compared to the reference circuit of the proposed exercise by providing the following message (Note how errors are always highlighte in red).



Step 2b

The user, therefore, changes the account «*bank loans*», non-pertaining to the circuit with the account « *Exchange risk* »



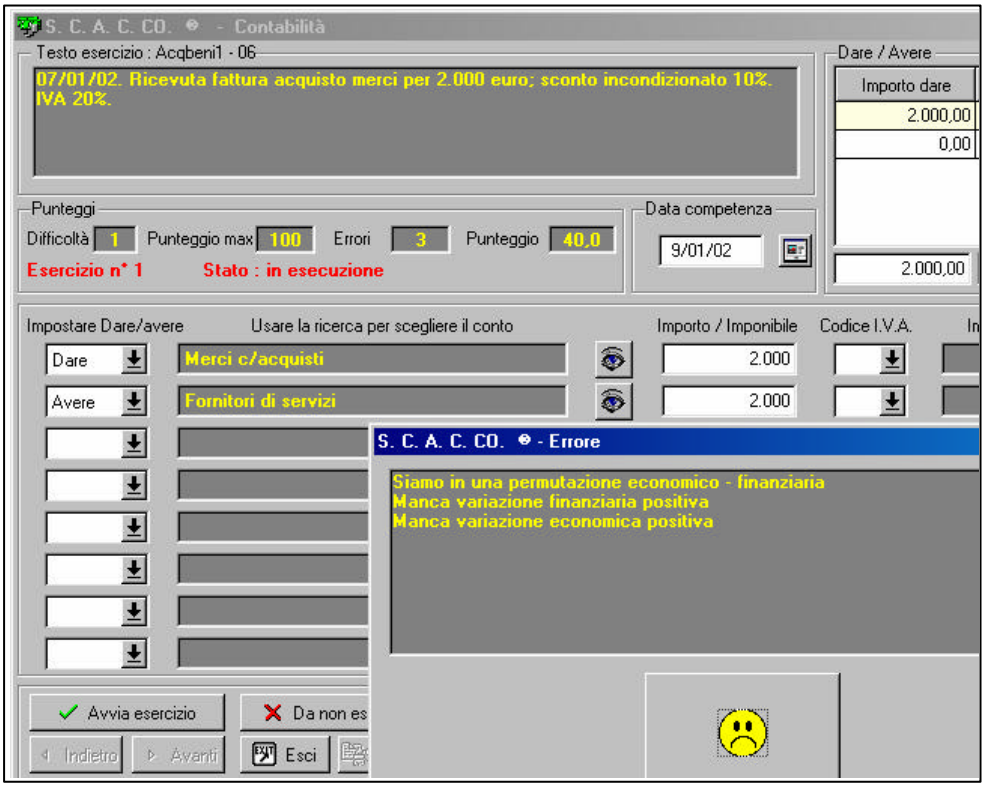
S.c.a.c.co. signal the user that performing yearly operations, the account used can be utilized only in the closure / opening operations.

An opposite error to that just highlighted is the one signalled by the software whenever the user upon closure / opening operations utilizes an account that can be used exclusively in yearly operations.

Step 3 (a and b)

The following filter focuses on the type of scheme of the operation used, and on the sort of accounts utilized (economic/financial). In this case, the student uses the accounts that cannot be utilized in the logic scheme of the operation proposed.

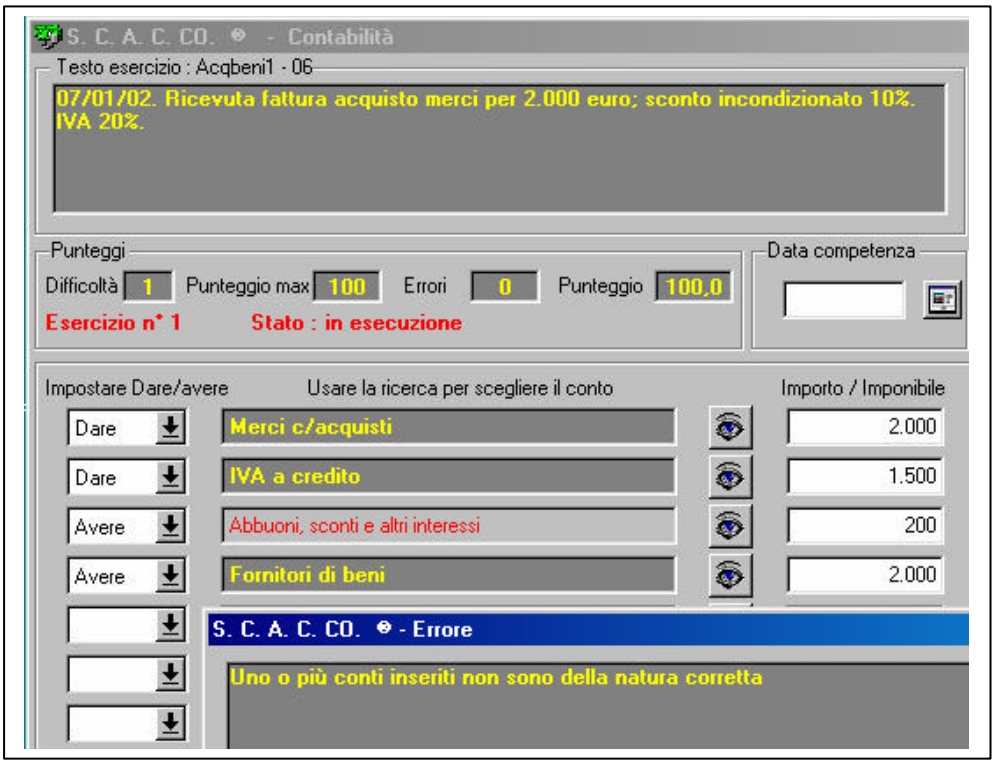
For example, through the abstraction process previously described, the model realizes that an operation requires two financial movimentations (one positive and one negative) related to two economic variations (one positive and one negative).



The user, on the contrary, has used a negative financial variation, which measures a negative economic variation. S.c.a.c.co. signals the lack of a positive financial variation and of a positive economic variation. The error at level 3 is very articulated, spreaded as it is in many "sub-errors". Such a scanning reveals particularly useful to the student, who may thus be more specifically addressed to correction. The latter will always be the result of a riflection, however, prompted by messages never originating mechanical reactions. With a view to it, after 2 repeated errors, the computer proposes the student the correct quadrant of the operation.

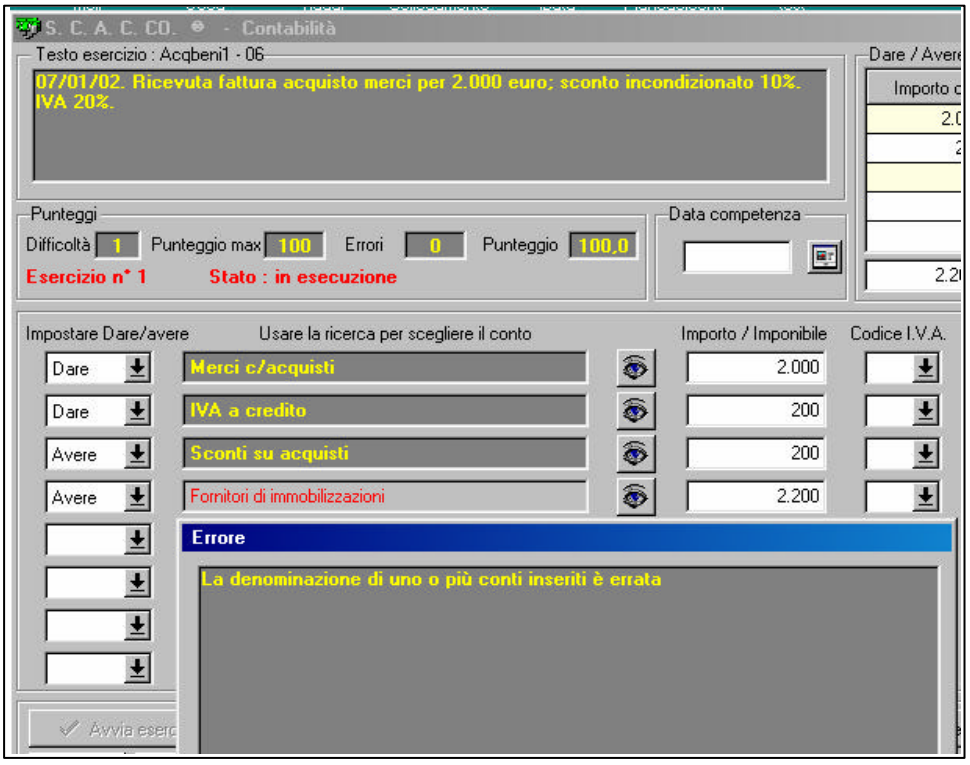
Step 4

Through such a filter, the error in the use of accounts of the correct type (economic or financial), but having different nature from that requested by the nature of the operation, is signalled.



Step 5

It consists in the use of accounts of the same type and nature of the correct ones, but with different denomination.



Step 6

This step and the next one analyse the quantification errors. At this level, the system analyses the balance of *"Debit"* and *"Credit"*. As we can note from the box on the up right hand, the amount of *"Debit" is* 2.000 Euro, whereas the amount of *"Credit"* is 2.400 Euro.

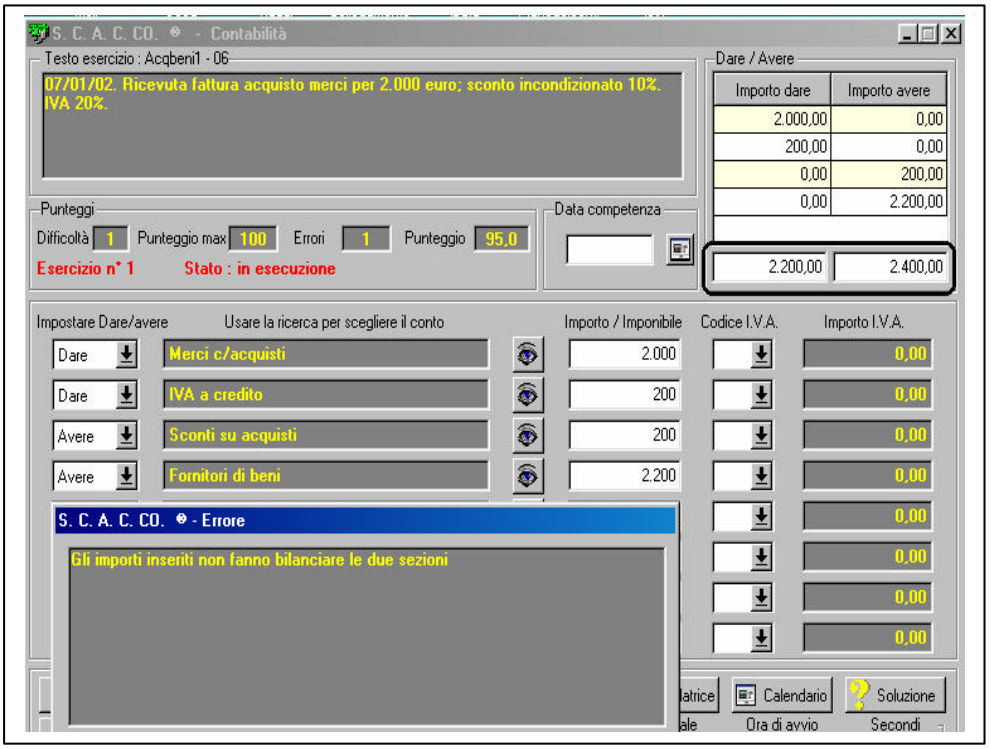


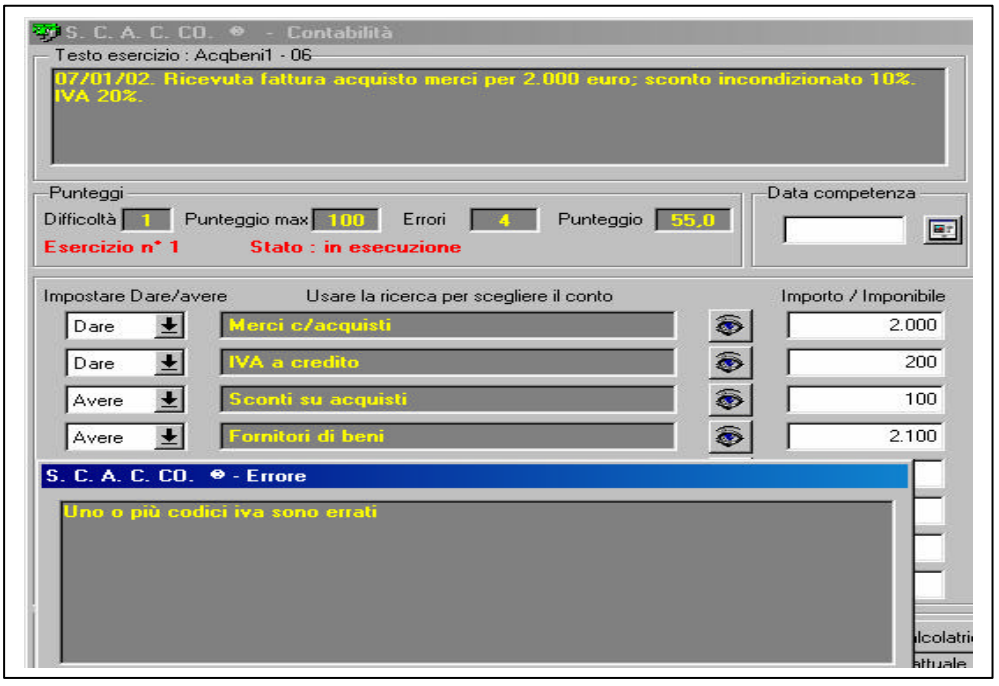
Figure 6

Step 7 (a)

The system checks the VAT codes used. At the second error, it will propose the account with the correct Vat.

Step 7 (b)

The system verifies the existence of any incorrect value relevant to a certain account. After the second error, it begins signalling the correct amount to each account with wrong amount.



Step 8

In this step, the correct «timing» of the exercise is checked-up.

As we can see, the range of filters is organized hierarchically, in that, due to the relevance attributed to theorical aspects more than to bookkeeping aspects, the filters on the moment, nature of the accounts preceed those regarding the denomination of the accounts and the relevant amounts.

The system, then, per each exercise executed, is able to draw a *final chart of the errors made* by the user, distinguished per single steps previously analysed. Moreover, the time used to execute the single exercise is reported, together with the vote in thirtieth and a ranking of the exercises executed more rapidly and with a higher score. This form can be printed.

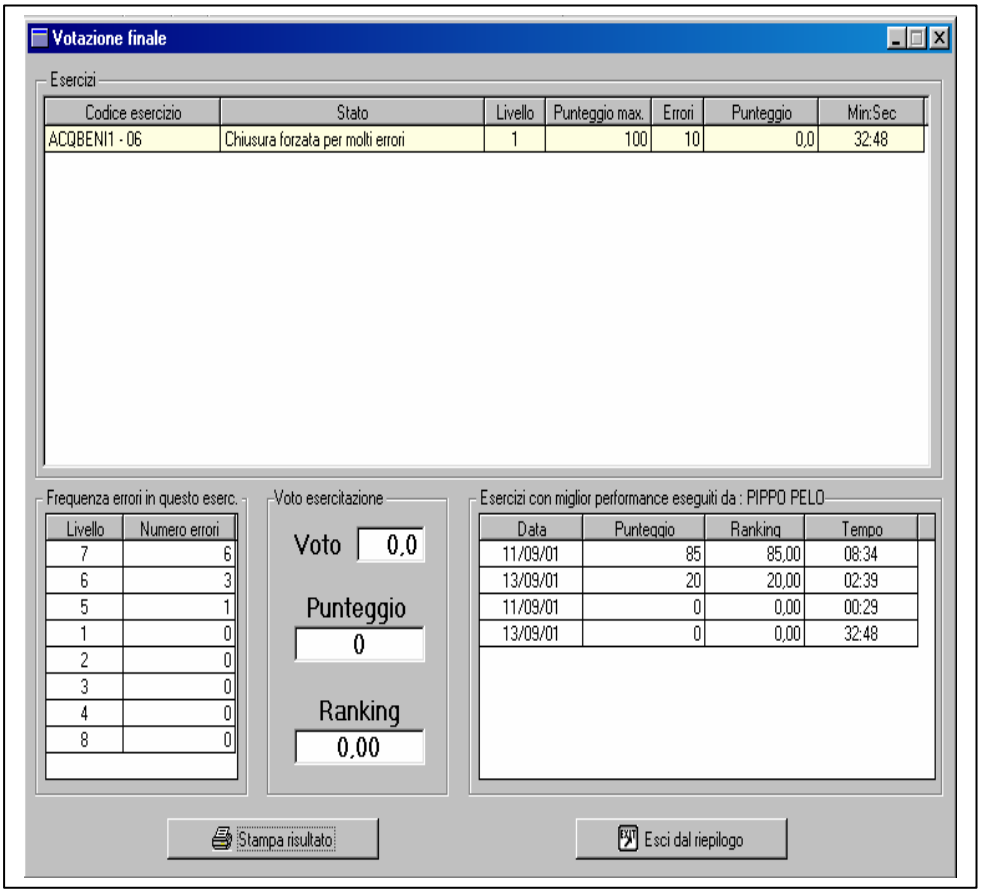


Figure 8

5. Concluding remarks

The expert system S.C.A.C.CO. allow to simulate accounting competencies of a very clever accountant according to the Italian tradition. The model allows to simulate student learning process and teacher evaluation criteria. It help the teacher to solve many problems.

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