Physical virtual laboratory

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Abstract— Applications that could be used during class presents projection characteristics, which confers them the quality of educational software and it's the didactic strategy on which the using and projection is based on. Included in this document are presented aspects related to the projection and using the simulation software, how the impact software – student can be optimized, which is the relationship between the simulation software and the laboratory experiment. Base don the resented experiments during this document is also point out how to use LabView in physics lessons, these applications being realized for different chapters from the school lessons of first years of high-school.

Key words — educational software, simulation, virtual laboratory, LabView.

1 Introduction

As teachers, we confront with students who have needs and distinct problems, which request the method diversification which should help each of them to have a chance in a society who wants to be integrated in the European Union. This means more than knowledge acquisition, and their integration in a coherent system, and also practicing the investigation and learning techniques.

Fighting for using the information technology and communications in the modern school, we'll remember since the beginning that through the proposed activities we want to establish equilibrium between the formative and informative process. By develop the informational network are opened gates to a knowledge which is built step by step, by facing permanent models with reality, by facing the opinions with dialog.

Projecting our activities, so that the students to be used with the permanent confront of models and real systems, we could minimalism one of the important risks existing in an informational society: people next by a computer could become a prisoner of a virtual universe, model type, less and less open minded, less and less involved in day by day life. That's why is important to structure an educational environment in which the personal experience to be the before the theoretic act, abstract, having as main objective step by step formation of an equilibrate personality.

2 Studying per model – a stage of scientific research

Studying physics we define models for different physic systems, confronted with the real systems, is an important stage of any scientific research. That's why simulation software and the laboratory experiment could be components of a cluster that allows developing of activities for which is important the finalization because of the perspective offered by confrontation between model and real system. In the interior of simulation software cluster exists a relationship in both ways:

- Projecting a simulation software will be realized transfer per model of the obtained information after studying the real system, being an argument for a proposal that this kind of applications to be realized also by the students (represents also another way to solve a physics' problem, agreed by them);
- The reverse relationship, simulation software – laboratory experiment, starts from two aspects: simulation can have an anticipative character, could be identified optimal conditions of the laboratory experiment progress; another aspect is related to the need of validation of different suppositions regarding the real system, and based on a simulation, many times, we could obtain answers for a new experimental research.

3 LabView simulation

Having classes/ groups of students with different problems, could be efficient that different simulation software to be realized by the teacher, because he knows students difficulties. This type of applications presents an important advantage: possibility to visualize the way how a model is acting in the conditions made by the user. Also could be pointed out in short period of time more particular situations, being offered through a single application for a package of problems for a known problem. Learning sequences, which that be built using the interactive applications could be selected by the teacher, but exists also the possibility that this could be generated by the student, discovered new aspects, which are properties of systems. It could be then asking questions, for which the answer it can

be found exactly in this applications. In other type of situations we could rely on different software in order to allow to the student practicing in his own way of work.

Applications made by us using LabView includes also working tasks, the virtual experiment being proposed, usually, to determine the value of a measure necessary to describe the evolution of the system. Having as objective student confrontation with different investigation methods, following also practicing in their own way, we projected the applications that so by using them the student can go over the main stages of the experiment, knowing the method principle, working way, recording of the experimental data, projection of an algorithm for data processing, making conclusions.

Applications presented in figure 1 and figure 2 offers different experimental methods in order to determine the compliance constant of a resort, being selected projection solutions so that the virtual experiment to be equivalent with the real one. For the applications, which present the equilibrium method, user will select different values of the mass of the body, which is hanged of the resort, for a specific value of the compliance constant, the system configuration is modified accordingly. User will read on the rule value of resort strain and will fill in a table this value, and in the second table will be recorded masses of bodies, hanged one by one by the resort. Application diagram will display the experimental points, and also the sequential order of these points, being necessary that the student make a correct analyze of the diagram and to extract the useful information.

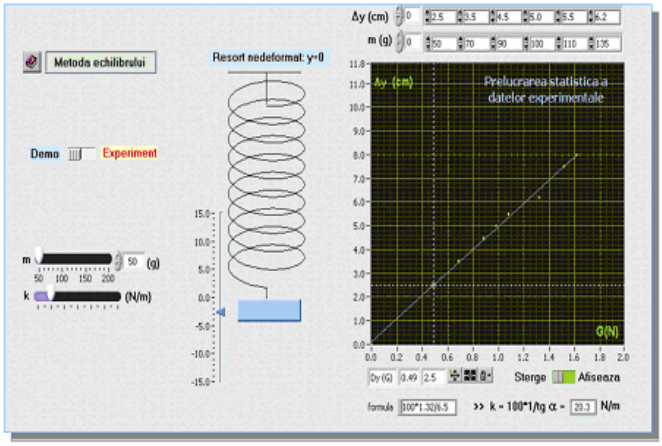

Figure 1. Sequence from the frontal panel of the application "Determining the compliance constant of a resort (equilibrium method)"

"Demo" section of the application presents to the student the theoretic curve of the resort strain that depend on the value of the straining force, being also presented the method based on which could be obtained the solution of the proposed problem. To have in target practicing of the way how it could be obtained an experiment conclusion, analyzing the recorded data, is important to take into discussion and to be presented to the students different processing possibilities, in the above mentioned application being used the smallest square method.

By projecting the application presented in figure 2, we wanted to prepare another laboratory experiment, in which data are acquired using the computer. To realize this kind of experiment it was necessary student accommodation with the way of data processing and extraction of the information.

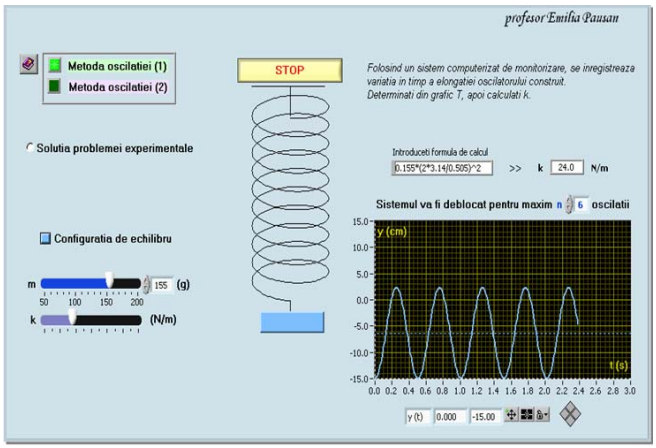

Figure 2. Sequence from the frontal panel of the application "Determining the compliance constant of a resort (oscillation method)"

Using this software, the student will initiate oscillation by pulling out the system from the equilibrium configuration, application displaying variation graph during time of the oscillator elongation, in the same time with the simulation of evolution of the modeled system.

Information extracted from the application diagram allows determining period of oscillation; this value is necessary to calculate the compliance constant of the resort (in section of the front panel, for the sequence "Experiment", are inserted controls that allows introduction of calculation formulas, their results being analyzed by the program).

Using different simulations will be permanently followed, when it's possible, the real experiment, student will be confronted with questions like: "why in these conditions the system behaves this way?", how can we check in the laboratory this kind of behavior, which is the best methods for the real system?", in what kind of conditions system properties are easy to be pointed out?", "why the model doesn't behave in the same way with the real system?", etc. Confronting behavior of a model with a real system will be identified properties that make the difference between the two systems. Is also pointed out the necessity to built a chain of models in which the information will be amplified, easier models are as a particular case of the superior models.

Being proposed to the students realizing this kind of applications, they solve a physics problem, practicing in the same way many competences. It is recommended, for this

kind of proposal, using LabView program, which is accessible also to the teachers and students, because of the offered facilities. Remember that the programming language used is a graphic one, extremely intuitive, and the functions allow realizing complex applications.

Although, the possibility to make a hierarchic projection offers flexibility, being possible to be built independent application, this could be then integrated in software. We choose first applications which have been presented in order to be exemplified also this aspect, the resort built based on an independent application being useful to realize many applications, which proposed distinct problems.

Simulation of system behaviour allows in a direct way confrontation of the model with the real system. In classic way, we describe the behaviour of physics system by value tables, by mathematics formulas and/or by graphic representations. Not always and not for every student realizing and interpreting the mathematic calculations, and graphic representations, is easy to be realized. He needs time to accommodate with these, and the rhythm of each student is not the same. This aspect is an important item for projection of different applications, in the following presentation is presented software, "The linear oscillator" (figure 3). This allows to the student visualization of model behaviour, being also presented time dependence of different measures, which describes the oscillation (in the meantime the application presented in figure 2 offers to the student only the information useful to solve the proposed problem, this new application allows a detailed study of the linear oscillator behaviour). Graphic representations are built simultaneously with the system evolution, equivalent to the recording of an electrocardiogram, which allows that the signification to be easily understood.

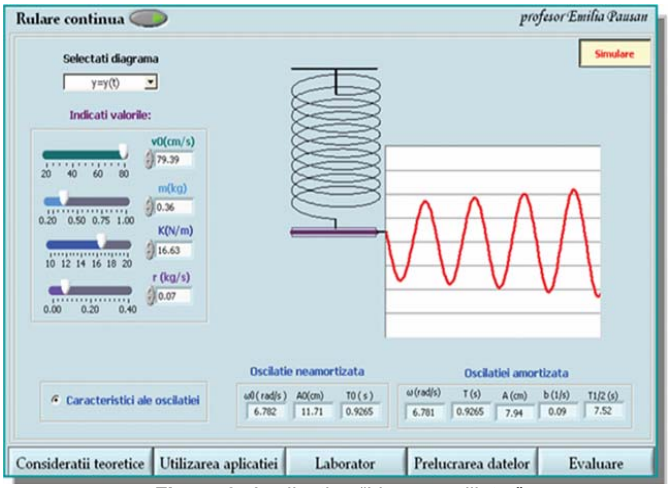

Figure 3. Application "Linear oscillator"

By processing the experimental data could be obtained characteristics of the oscillation: period, frequency, value of damping coefficient, etc. Remember also the fact that presented application in figure 3, in which is simulated behaviour of the linear oscillator, includes as a particular case the simple model of the harmonic linear oscillator, being pointed out to the student limits of this model, corrections being made by a superior model.

In physics study, it frequently modelation by graphic constructions, and using an interactive application it proves to be more efficient than using the plans. Using a similar application as the one presented in figure 4, student will be familiar with the graphic drawing that allows visualization of image characteristics in a convergent lens, having the possibility, that in short period of time, to surprise different aspects, obtaining a big number of particular cases. This application proposes also to make a virtual experiment in order to determine the convergence.

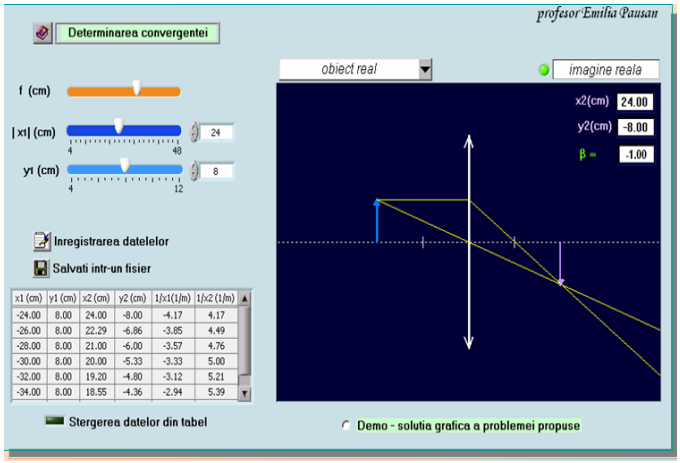

Figure 4. Sequence of the application " Convergent lens"

Based on this kind of application, before realize the laboratory experiment, student will be familiar with the working way, with the data processing possibilities, discussing the solutions presented by students being important especially for making a successful laboratory experiment.

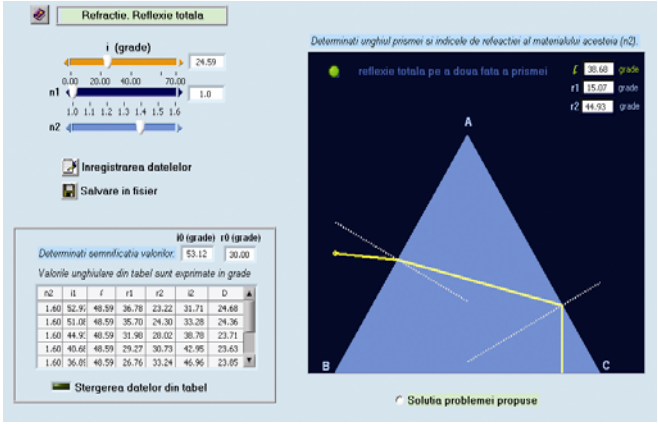

Figure 5. Sequence of application "Optical Prism"

The application presented in figure 5 propose to study the refraction phenomenon in a prism, could be pointed out particular cases of interest (in the illustrated sequence is presented the total reflection on the second part of the

prism). This application proposes also to realize a virtual experiment in order to determine the prism angle and also the refractive index of the environment when the prism is installed. To solve the experimental problem is necessary a correct use of the application information, based on the studying laws, could be an identified also particular cases that helps the student for the real laboratory experiment.

Graphic representations of different application presents important information for the proposed theme, by a correct interpretation of these data could be obtained connections between different measures, or to be deducted physics laws. In figure 6 is presented software built on order to point out mechanic energy conservation. Simultaneously with the evolution of the modulate system (gravitational pendulum which could be pulled out from equilibrium configuration), is presented in diagram: application of time variation of kinetic energy, a potential energy, being given also the sum of these two components. User has also the possibility to record in a file experimental data, these being presented in a table in the front panel of the application.

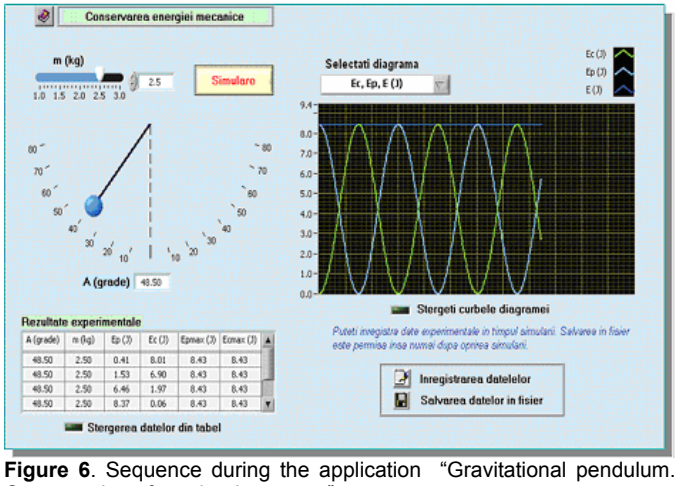

Figure 6. Sequence during the application "Gravitational pendulum. Conservation of mechanic energy "

Advantage of using simulation software is very good seen by applications in which are simulated system behaviours that cannot be studied in a school laboratory. In figure 7 is presented this kind o software propose a classic problem of particles loaded with electric charge who enters in an uniform magnetic field, their speed being oriented under different angles comparing with the field lines. This application has integrated a self-evaluation sequence, being proposed to the student in classic way, a physics problem.
Variables of the application are projections of particle speed on Oz and Oy axes, as well as value of induction of the uniform magnetic field in which the particle enters (field lines being parallel with Oz axe), application displays oscillation characteristics (period and beam of helicoids). As working action, student has to determine the particle type, particle's load, as well as some oscillation characteristics (oscillation period and pulsation, helicoids step).

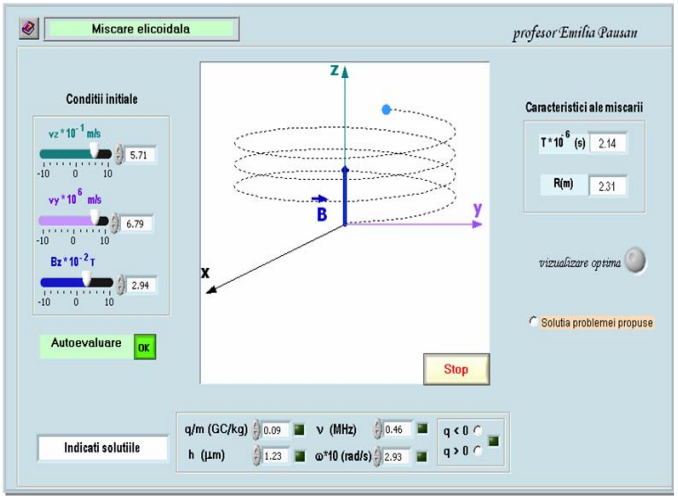

Figure 7. Application "Electrification of particles in a uniform magnetic field"

A part of the applications requests also to find solutions in order to realize the three-dimensional effects (see applications presented in figures 7,8,9). Generally, we proceed to define a perspective and to include this one in the software algorithm, could be used also other solutions, LabView program offers controls ActiveX type and 3D diagrams.

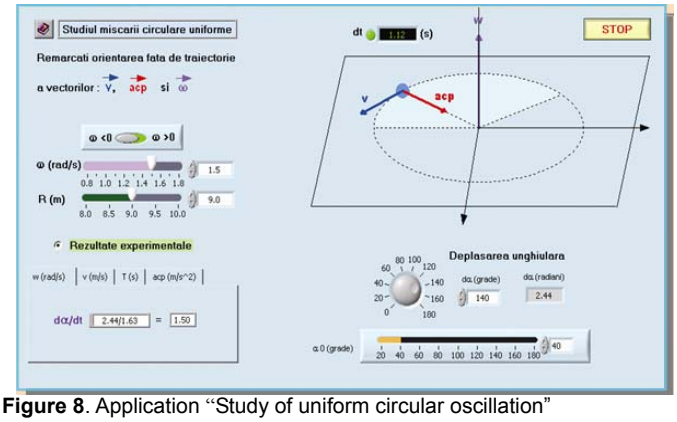

Figure 8. Application "Study of uniform circular oscillation"

Presented application in the above mentioned diagram, offered also to be seen a three-dimensional effect, points out, that for an uniform circular oscillation, are realized angular movements in equal periods of time. User will select value of the angled movement and its position on the trajectory, the application displays time period in which the angular movement is realized. There are also presented linear velocity vectors, angular velocity, and centripetal acceleration vector. Modification of the rotational sense is accompanied by the corresponding modification of velocity vectors, being requested to the user to established connections between represented vectors during application.

Using the same projection method in order to realize three-dimensional effect, was built another application, which completes the one prior presented, being proposed the classic problem of conic pendulum (see figure 9). This new application points out system actions, which guides to a uniform circular oscillation, rising this way problem of this kind of oscillation.

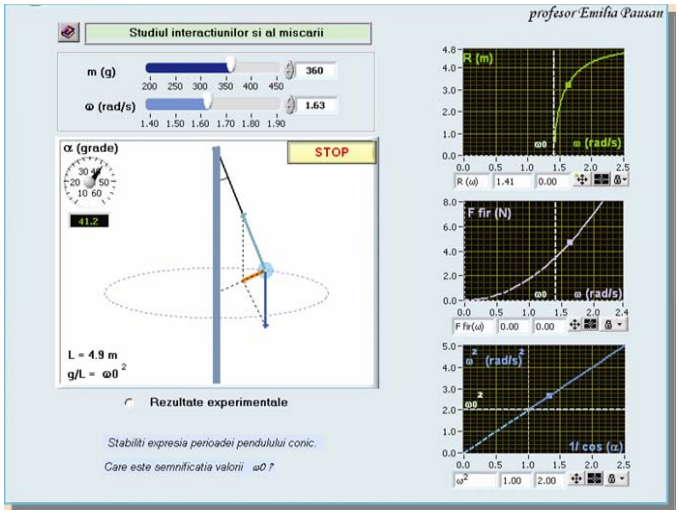

Figure 9. Application "Conic pendulum"

Generally, for each unit for which have been projected different applications, we realized also evaluation/ self-evaluation tests. In despite of tests integrated for some applications, tests projected for the evaluation made at unit content level have been realized as well as pointing sequence to be displayed after fulfilling all tests items (figure 10), in this sequence being presented also solutions indicated by user, and also correct solutions.

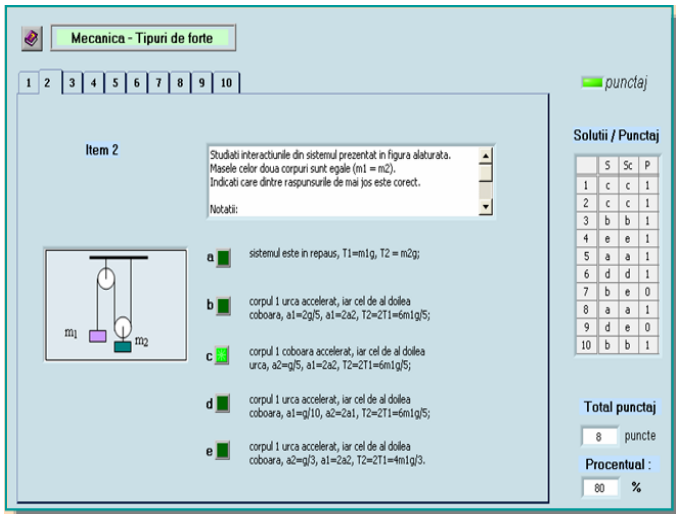

Figure 10. Test for self-evaluation, projected for the content unit "Mechanic interactions. Type of strengths"

One of the items of the presented test proposes the experimental data interpretation, student having the possibility to use, during test, an application for data processing. This type of item have been proposed to check the modality use by the student to extract the requested information based on graphic processing that could be realized using the software (is requested determination of the value of resorts' elastic constant, being presented experimental data obtained based on a laboratory experiment: values of resort strain and straining strengths).

Most evaluation/ self-evaluation software, projected for a content unit, has an item in which the student is asked to realize a virtual experiment to determine the value of physic measures, system characteristics of the proposed system. In figure 11 is described a test for the content unit "Direct current circuits", item 4 of the application requests to determine the electric resistance of one of the circuit resistors, could be used a zero method (user will modify values of electric resistance belong to other resistors of the bridge until the galvanometer will indicate zero value – this way the bridge being equilibrated). Theoretic knowledge of the proposed theme is verified, but also how these are used to project and realize a laboratory experiment.

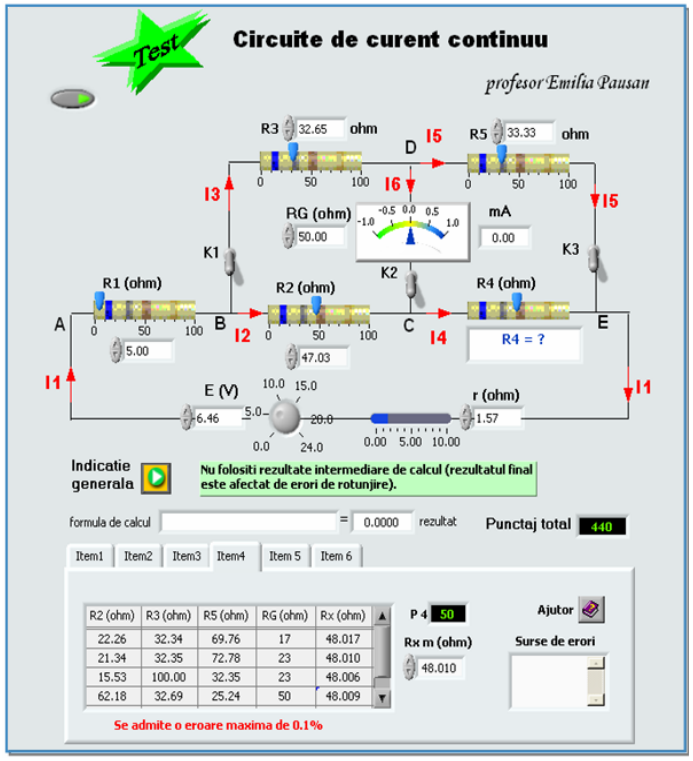

Figure 11. Test for self-evaluation projected for content unit "Direct current circuits".

Even the simplest applications, which could be realized using LabView, we propose interesting problems for school hours. Based on interactivity and didactic strategy included by projection, this type of applications could be integrated in a physic case that could be used by a student also in school and home.

4 SIMPLE SOLUTIONS, EASY TO REACH, TO REALIZE INTERACTIVE APPLICATIONS

Reminding that physics' teacher could realize small applications, being necessary a good algorithm, which can be then demonstrated in many programming methods, is proposed a simple projection solution of an interactive physics application, using Excel program from Office package.

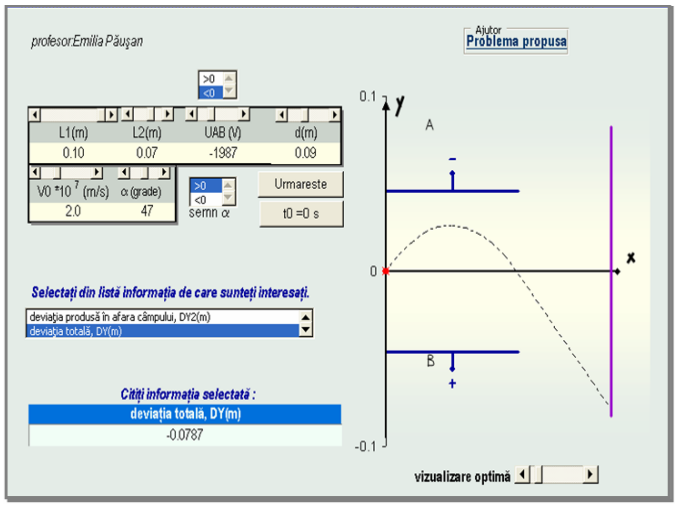

Figure 12. Sequence of application "Electrified particles in uniform electric field"

Applications for classic problems could be easily realized based on this program. For exemplification is presented in figure 12 an application in which is simulated behavior of electrified particles in electric uniform field. User can modify distance between plates of capacitor, distance from this to the screen, speed value and orientation of particles that enters in field, electric voltage applied to the capacitor, as well as the polarity. This way could be obviously see particular cases, the application displays useful information to describe the evolution of the modelate system.

Proposal to use Excel, which is optimal for the students who don't know a programming language, is easily proven. Near the obtained interest by proposal to project physics application, is not necessary to create to the student a problem, which is harder then the initial one.Here is the biggest advantage of using Excel: is extremely easy to use and, practically, high-school students are use with the base elements of it. This way, accent will be on a good algorithm and a good knowledge of physics laws and principles, without their applications have no content. More than that, interest for correct functioning of an application will make them to open one more book, or to ask more questions, and team activity is a useful exercise.

5 CONCLUSIONS

We proposed in this document to expand the physics case with a new component, necessary to make the model study, which includes simulation software. These proposals are proved by the fact that simulation software allows:

- Visualization the model behaviour, in users' conditions;
- Pointing out, in a short period of time, of more particular cases, which are important for the study of the proposed theme;
- Simulation of some experiments, having as target accommodation with the experimental method, as well as different possibilities of data processing, or of the experiments that cannot be realized in a school laboratory.

By student involving to realize simple simulations on the computer, following all the stages starting with the hypothesis, developing the mathematic formalism, to the model confrontation with the real system, is good to remind that:

"Hypothesis has to be considered only as an asset, never as a target" (T. Huxley),

Or that

" Writing adequate postulate is always possible to be realize mathematic systems, as Euclid did, but we cannot realize a world mathematic, because sooner or later will be forced to see if the axiom are valid for the objects from nature (Richard P. Feynman).

So, it's important not to forget:

Computer is an instrument which can be useful or not, it is depends the scope in which we are using it. New characteristics could be given to this modern instrument, and the evolution of today society offers new methods, instruments and solutions.

[1] Marius Munteanu, Bogdan Logofătu, Reimer Lincke, "LabView virtual instrumentation" (Credis, Bucharest, 2001);

[2] Marius Munteanu, Bogdan Logofătu, Reimer Lincke, "Applications of LabView virtual instrumentation " (Credis, Bucharest, 2001);

[3] Tom Savu, Gabriela Savu , "Informatics – Technologies assisted by the computer", manual for 10th year of study / technique profile (ALL Educational, Bucharest 2000);

[4] Mihaela Garabet, Anca Voicu, Emilia Păuşan, "Information and Communication technology in modern school" (Credis, septembrie 2003).

[5] Emilia Păuşan, "Physics interactive applications. Excel " (Credis, December 2003).