

Modern teaching methods in physics

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Abstract*The perfecting course “Modern teaching methods in physics” is an educational program for physics teachers, taking place at the “ Teacher Training Center” in Bucharest, Romania, and was accredited with 30 credits, starting with the 2003-2004 school year, modulus I. The other modulus will take place in the following years refers to both the physical curricular area and the general area of integrated sciences. It implies both the speciality aspects and the methodical ones in accordance with science teaching. The proposed system refers to a four-year modern thinking developing plan, each representing a speciality and a methodical modulus.*

Keywords. educational program for physics teachers, methods in physics , modern teaching, “ Teacher Training Center”.

1. The utility of the program of continuous developing in PHYSICS and SCIENCES

The proposed program for the perfecting of physics teachers is according to the policies and strategies of national developing of the educational system set by the Education Ministry.

This aspect refers to the fact that the proposed objectives in continuous formation is at first hand according to the standards set by the National Committee for Continuous

Formation for personnel in pre-university learning. This refers especially to the application of optimal algorithms in designing, organisation and evaluation of the teaching activities. Thus an accent is set on the adequate use of the general teaching methods and speciality teaching methods knowledge. Among others this means the integration and the proper use of auxiliary didactic materials in the process of learning. Common for physics are experimental and demonstrative activities. An other aspect is the developing of critical thinking and the use of the creativity developing techniques. As a result the teacher becomes more confident and this aspect is felt through a balanced behaviour thus setting an example through himself.

Not least what is searched for is the developing and actualisation of professional knowledge, of knowledge regarding aspects and techniques of statistical evaluation, which imply simple mathematical and didactic statistics knowledge. Finally, all these are discussed in resembling conditions with those existent in competition situations.

As usual computer using capacities in class are developed. In this purpose Lab View modulus utilisation is promoted, modulus recently introduced in schools. On this occasion group studying is exercised and learned.

A few problems have been spotted and evaluated as being important:

I.) The difficulties that teachers have in the completing of laboratory works:

a. the way measurements are confronted with

b. the employment of school kits;

II.) The experience of checking of correct behaviour of devices used in the laboratory, searching for causes of defectuous behaviour, the lack of imagination in the use of devices and in the conceiving of simple experiments with a maximum conscientious impact, the lack of the idea of theoretical results checking on experimental basis;

III.) The lack of experience in drawing conclusions from the experimental data as in the efficient handling of graphics, calculus and the necessary duration of measurements;

Younger teachers have difficulties concerning the way of solving of more sophisticated physics problems, that are less employed, there is a massive lack of experience concerning open problems, the teachers don't even have the courage nor the options of a creative work, they don't have the horizon of physics problems abroad (there is a powerful provinciality, determined by the lack of information sources, information time, experience exchange and especially thinking!).

IV.) The lack of documentation and daily information on both scientific and methodical domain.

In conclusion the following objectives and perfecting ways are proposed:

a. the perfecting must be made on experimental and practical basis especially, and less on theoretical basis

b. the perfecting of the teacher will also have an individual working component (home) which would extend on a large time period and would consist in solved homework, problems, questions or papers which the teachers would bring every month. This activity is marked, as the whole activity, through cumulated points throughout the study period.

c. during the perfecting process a climate necessary for a relaxed, informal, open discussion between collegs must be set, because people of equal levels of cultural and professional qualities are discussing. This activity must begin to hold this aspect of intelectual discussion and interaction and debate, and not the aspect of teaching a specific number of

classes, in a fixed and rigid timetable. The flexibility of intelectual work must be properly recognised, prepared, preserved, encouraged and institutionalised.

d. it is also obvious that the reform is not decreed, but it is "worked" daily, it is thought, experimented and better conditions for a more or less advanced future are created, partial results are evaluated, methods and directions are corrected, taught and retried and, in probably ten years'time, it could be said that the reform would have begun to materialise, but it would be certain that it would only continue. The reform is very much in relation with the material part of learning and also with the spiritual and cultural side of it and the people involved in it. It can not be hoped in a factual realisation of the reform without the moral, ethical and professional change of the people involved. In this direction an increase in the general knowledge degree of the teachers is required, and also the small scale setting of the climate we wish to accomplish on a national level and especially believe in what we are doing and what we wish to accomplish.

e. a severe lack of scientific, cultural and organisatory information in teachers is observed. The reasons are the lack of books, magazines and other documentary physics materials and learning materials in general (both basic books and new books and magazines) which can be substituted by the classes and discussions. The material and informative basis with which this course is prepared exists and is sufficiently abundant.

f. the purpose of the experiments and practical activities in physics classes and in classes especially elaborated (laboratories and laboratory technique classes is to allow the student to develop experimental skills, that is the skills necessary to work, experiment, measure and single-handedly build physics devices and experiments. It is thus possible to track the evolution of the student. This aspect cannot be accomplished if the teacher himself does not have this ability and practic. One of the proposed purposes is exactly this aspect.

g. general knowledge implies both humanistic and scientific knowledge,

both of them being human creations and thus proper thinking of these aspects must be instated. The fact that needs to be realised is that physics would have to be thought as a humanistic form of culture, which would mean that in the physics classes not only the formulas and the abstract aspects would prime but also the aspects that humanify physics as a science of nature. One of the proposed purposes is the “humanisation” and the transformation of physics and science in pleasant and attractive study classes. In conclusion an accent will be set upon the scientific culture and its integration in the general culture fund. The interdisciplinarity would be a continuous presence in these classes.

h. there are lots of aspects of nowadays science that need to be acknowledged by a teacher in order for him to perform an efficient teaching act and especially knowledge from the adjacent sciences, which nowadays give the process of learning another image and a scientific basis to lots of aspects considered intransformable. These kinds of directions which will be discussed in the perfecting classes are: information theory, neurology and cybernetics, the complexity theory, non-linear dynamics, statistical thinking, etc.

i. the course is addressed to both gymnasium physics teachers and teachers from highschools and in certain cases could prove to be useful to natural sciences teachers regarding an interdisciplinary view of natural sciences.

j. . in consequence, the proposed course as well as its accomplishment method, holds the entire range of problems which learning reforms and programs nowadays sustain in view.

2. The structure of the continuous formation frame-plan

The perfecting course “Modern physics teaching methods” refers to both the physical curricular area and the general area of integrated sciences. It implies both the speciality aspects and the methodical ones in accordance with science teaching. It is totally adequate and according to the purpose of the program.

The way the courses are organised refers to the accomplishing of teaching courses and discussions with teachers in the form of thematic seminars. It is also insisted on practical activities, both experimental, and concrete ones realised in classes. Among others these imply solving difficult problems. The teachers receive homework, which assumes the thinking and evaluation of some materials, as well as solving certain aspects implying creativity.

The proposed system refers to a four-year modern thinking developing plan, each representing a speciality and a methodical modulus. The specialty and the methodical one are not conceived to be separately discussed and taught but to be in continuous transition from one to the other according to the theme, receptivity or difficulty which the students show.

The four large groups form a whole, but in the same time are independent from one another. The system is thought as to be chosen by the group of students as to be fitting their own proposed perfecting process. Therefore a teacher may go through a modulus in a time span of four years or numerous moduluses according to interest and a possible resuming in the next four years allows the choice of other theme groups, according to desire and necessity. The themes of choice are general enough to have the flexibility of being taken over during the ongoing processes of modern aspects taking in consideration the rapid developing of science nowadays. The necessity of flexibility and adaptability of the program allows questions appearing on the way to receive a general frame in which to be introduced. The rapid pace of information sending towards the student and the teacher, through the media, requires this aspect.

The proposed objectives are:

I.) The actualisation of scientific and methodical information;

II.) The accomplishing of experimental skills of the teachers; the returning of a certain freedom and confidence degree to the teachers regarding experimenting, the construction of simple devices, the increase in the observation and prime observation systematisation capacity; involving the children in the pleasure of

observing, discovering and free experimenting.

III.) The fortifying and the development of the scientific spirit, of the scientific thinking, of the reasoning both as a scientific method of investigation in science and as thinking in daily life; the practical use of formal logic, specific to scientific reasoning.

IV.) The completion of math knowledge necessary to physics, especially to the statistic aspects, which also imply at the same time the use of tests, correct evaluations of statistical results, uncertainties of statistic margins of some measurements (scientific or scholar) etc.

V.) Providing teachers with a certain interdisciplinarity in the direction of the spanning of the scientific horizon, the introduction of the global holistic thinking and the use of science in everyday life.

VI.) Knowing and experimenting different methods of information technology and computers as a complementary part of teaching activity; the knowing of both simple approximation procedures and practical accomplishment of some multimedia materials and their correct use; using interfaces for data collecting and their automatic introduction in to the computer (virtual laboratory); using informatic environments on CD-ROMs or encyclopedia type of disks or other dedicated programmes; work on the Internet and search procedures, etc.

All these aspects create teacher competences but also enhance speciality and methodical knowledge and also ensure a live experimentation of the ideas discussed.

Working modalities are different and vary from one theme to the other. Generally speaking, for a perfecting course to be viable and provide results, it has to be a live exemplification of the ideas it generates and discusses. It is without a doubt an obvious affirmation, but practice shows that the majority of methodical courses are purely “theoretical” no methodical, psychological, or learning character, thus being taken as “lessons”. Practical modalities will be, from case to case, the exposition, the seminar (discussion), the practical achievement of certain experiments – either frontally, either with every group of teachers, and in the great majority of the cases homework

corresponding either to searching materials or writing essays, either the continuing or materialisation of home experiments are provided. Generally speaking the themes will emphasise the solving of certain current necessities of teaching in class of some teachers, at their own request. These situations are treated as examples of methodical or scientific problems to which course students participate with their own points of view and an option considered optimal is reached. After the completion in class of the discussed themes, a discussion of the results and the analysing of methodical results are made.

Because of this working method, the evaluation is made gradually, it contains observations and grading to all forms of learning, including the activity in the discussions of current problems. Experience shows that this method of evaluation is the most efficient and the most correct for the level of the teachers because they do not need to be treated as simple course students, but as teaching activity colleges. This way of emphasising the problem not only increases interest and makes classes more dynamic, but in the same time gives the course teacher dignity and the results are excellent. The method complies to all aspects the reform imposes and especially ensuring a different learning climate not only in theory but also practically. Psychologically speaking, this method allows an open and relaxed attitude in teachers, with a maximum effect on the perfecting process.

The time proposed to achieve this kind of classes, speciality and methodical, is about a hundred classes divided in approximately 50% speciality and 50% methodic. It is proposed to realise them in four hours a week (9-13), every Saturday of the month, except holidays. The continuous evaluation will be made as reminded, during seminars, practical works, discussions and correcting homework (ten extra hours at home). The completion of the courses will be made through a discussion on the way the teachers responded to the problems posed, with emphasising good or bad parts of each one and a grade “pass” (very good, good, satisfying) or “fail” (unsatisfying).

3. Specialised themes

Module I : 2003-2004

Physics history

- a. Mechanics from Aristotel to Galilei and Newton
- b. Structure of the matter: philosophical aspects

Physics experimenting methods

- a. Using school kits
- b. Using constructed devices
- c. The homework method
- d. Teaching methods

Module II : 2004-2005

Modern physics

- b. New physics
- c. Modern astrophysics
- d. Physics as experiment and direct observation of nature
- e. Descartes and “Speech about method”

The computer as a means for learning

- a. Computer using methodics
- b. Multimedia procedures methodics
- c. Internet integration and distance learning methodics

Module III : 2005-2006

Physics, chemistry, biology and maths under interdisciplinary aspect

- a. “Transformation, process, developing, evolution”
- b. Modern physiology and psychological evaluation of children

Complexity science – a new way of understanding learning and education

- a. Dynamic nonliniary systems and fractals
- b. Hierarchycal knowledge structures – optimization of the learning process

Module IV : 2006-2007

Mathematical aspects involved in the description of physical phenomenons and also statistic thinking development

Models and modulation

- a. Statistic aspects in drawing conclusions
- b. Statistic thinking and the evaluation of knowledge
- c. Grades and credits

4. Bibliography

This contains an informative role on existent books in the country that have been used on different ocasions at courses of :

- a. *perfectioning and recycling teachers* in Bucharest, “ Teacher Training Center”, 1992-1994, *methodical confernces* with teachers from around the country (since 1970)
- b. *Physics teaching methods*, at the **Faculty of physics** in Bucharest
- c. *Modelation, simulation and visualisation of physical phenomenon course*, at the **Faculty of physics** in Bucharest
- d. *Research aspects regarding methodical and the teaching of physics* as well as *studies regarding the educational system and knowledge theories through nonliniary and complexe Systems*.