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PHYSICS EDUCATION

THE IMPACT OF INTERDISCIPLINARITY ON THE PHYSICS-MATHEMATICS SCIENTIFIC EDUCATION IN HIGH SCHOOLS*

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Abstract. The necessity of an interdisciplinary approach of education arises from the impossibility of science, any of it, to globally investigate the complex problems of reality. However in general, the results of each science are specific to a given discipline and it represents the limited research models of the human being and the world. Because the science is very significant in the development of all education components and of modern education, including the school curriculum (epistemological, teleological, content, methodology), we can now conclude that no contemporary school can bypass interdisciplinary problems.

Key words: interdisciplinarity, facultative school discipline, complete curriculum, curriculum at school decision, high school education.

1 INTRODUCTION

Current education issues are particularly complex because of the knowledge progress and because of the interaction between science, technology, education, and solving them require some assembly of the science and education elements efforts. In this context, marked by an unprecedented information explosion, it becomes more current the sentence "Non multa, sed multum" which considers essential the quality of the knowledge's but not their volume**.** Interdisciplinarity becomes an integrating principle from a regularly schooling and education one. As a general principle of knowledge, interdisciplinarity is the concrete manifestation in schooling and education of a general universal education principle of world unity – completeness. The incorporation of scientific knowledge in modern education proves to be the principle and the definitive activity of it, which is made to the projective and concrete level of transposition.

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Interdisciplinary nature of sources of a relevant content involves an *interdisciplinary approach*, their selection and their organization cannot be done on the basis of monodisciplinary ways that are in competition and that have in sight disciplines with closed boundary. Promoting an interdisciplinary approach involves correlating in a perspective of pedagogically approach of all useful steps in analyzing the content sources and in its organization [1].

Integration does not mean and should mean not an alignment or cancellation of interest's diversity and preferences. For example meeting between different discipline placing or increasing share of the synthesis hours, learning with computers, through which some specialists see how the way to articulate different categories of values and existing knowledge's. By the principle of integration it is required the articulation of curricular contents, required, which provides that *basic education*, with curriculum areas corresponding to other phase of the educated subjects training processes, under the enormous diversity of training profile offered to them by a rigorous joint of the formal content with non-formal one and in-formal [2, 3] ?

Trying to articulate the different types of information collected and to introduce a certain coherence in the minds of students to meet their spiritual needs-to discover unity in diversity, to rise above the immense informational mass that assaults them and to get to their own conception, what the French teachers name through the expression "vue d'aigle" (sight of the hawk).

The curriculums but especially textbooks can not be identified with the contents because they have parts significant to teleology and methodology (including to evaluation). By making a parallel between traditional education, discipline-centered, and the desirable one, centered on the requirements of whom is learning, H. Shane and B. Tabler [4], shows the magnitude of the changes that are to be done. They are followers of courageous and profound transformation in reforming the contents and thus they belong to a kind of educational radicalism. The educational framework plans allows schools to offer to students the possibility of choosing discipline from the offer of optional courses. Such an offer is for example the one in which are occurring optional subjects corresponding to each curriculum area of Mathematics and Science. Macro-concepts construction requires proposing some optional courses thought from an integrated perspective, meaning some optional courses made with the contribution of more study disciplines**.**

2. THE CONCEPTUALIZING AND THE DESIGN OF OPTIONAL DISCIPLINES IN PHYSICS AT GYMNASIUM AND HIGH-SCHOOL EDUCATION

Interdisciplinary approach is a necessity in case of complete curriculum, based on students requests, on objectives and contents that fulfils physics and mathematics disciplines in application of an interactive methodology; the

curriculum model centered on the students knowledge's contributes to achieving a formative model and the interactive methodological approach opens the way to interevaluation in the spirit of premise: *learn to act* – definitive ideas, in our research, for projecting and validation of Optional course through experiment as a new discipline introducing interdisciplinarity.

The complete analytical curriculum begins with a detailed rethinking of the objectives and content distribution of optional subjects in classes V-XI, with the benchmark knowledge capabilities and attitudes designed to be formed at primary grades. To develop the curriculum for optional course it has to be pursued the following sequence of projection links in agreement with model of common trunk programs: *argument* – 1 page overview to present the aim of the course, *ground reference objectives* – it refers to learning activities that students are to reach up to the end of the school year (at one hour per week will follow 5-6 reference objectives), *list of contents* – it includes information which the optional course suggests as a operating base for capacities targeted by objectives, *methods of evaluation* – it will be referred to types of evidence of which correspond to the proposed optional course (egg.: written exams, oral exams, practical exam, report, project etc.) [5].

When the optional course is provided for a level of education or a curricular cycle, it is necessary to define *framework objectives* from which derives the reference objectives for each year of study. Thus said, if the offer includes an optional course on many more years of study, it is prepared a curriculum for each year, taking care to appear explicitly objectives progression from one study year to another. The logical reality of mathematics deductions and the exact picture of the world presented through theoretical and experimental facts in physics allows student to have a thorough and adequate preparation in the scientific formation of modern human and it develops the student interest to physics study an its applications.

The activity success in an educational institution depends on the growth quality of the educational process that is based on several factors: the quality of human material, the quality of logistics, quality of national curriculum, staff quality, and management quality. The ways of implementing interdisciplinarity at macro-educational level (plans, curriculums and school textbooks) can build up a real increase in education quality. Today the school, as much as the teacher, can interfere directly in the design of education because of the existence of curriculum to school decision (CSD).

The optional course as a new discipline introduces new study objects, in addition to those provided in the common trunk. If we consider interdisciplinarity as a conjectural alliance between different disciplines (in this case physics and mathematics), an optional course at the level of curriculum area in the mathematics and nature science could be of real use to students and in the same time to teachers. Establishment of some curriculum for such an optional course could offer to pupils the opportunity to a revision of physics and mathematics assimilated knowledge. A

study shows that teachers have received with interest such proposals which would develop communication skills using the specific language of physics in solving problems. If you choose an optional assignment to the area, then the least two discipline and skills from the disciplines of competencies will make reference to the chosen theme.

If it is selected an optional course at the level of curriculum area, then the theme implies at least two disciplines and starting from the framework skills of disciplines there will be formulated reference skills for the chosen theme.

3. EXPERIMENTAL STUDIES – REVEALS THE DEMONSTRATION OF THE OPTIONAL IMPORTANCE THAT PROMOTES THE PHYSICS AND MATHEMATICS INTERDISCIPLINARITY IN GYMNASIUM AND HIGH-SCHOOL

From the Latin "experimentum", the term experiment is seen as evidence, verification, experience and in case of pedagogic researches is the verification of one(s) hypothesis. Unlike observation, that pursues educational phenomena without interference from outside, the intervention in the experiment through intentional modification of the conditions of emergence and phenomena progress. These conditions are submitted to systematic controlled variations, the experimental data being recorded with objectivity. In accordance with theory, the purpose of the experiment is to confirm or refute the research hypothesis, which are knowledge sources in both cases and generators of new questions and hypotheses. The pedagogic experiment involves systematic alteration of a factor or group of factors and the recording of the obtained effects.

The experiment presented was conducted in 2007-2008 and was aimed to experimental validate of the educational objectives (specific skills), based on the decision of the school curriculum and demonstrate the importance of an optional that promotes interdisciplinarity in the teaching - learning process of physics and mathematics textbooks in V-IX classes.

Arguments for this option were:

• achieving scientific education from the perspective of interdisciplinary vision;

• gradually replace the summative nature of disciplines with the complete one, which moves the accent of teaching-learning process on the finality and situations of the content transfer.

3.1. Research hypothesis: Teachers who teach courses in physics and mathematics are teachers who appreciate the need of interdisciplinarity between the two disciplines.

3.2. Batch description: the experimental batch of research in made of:

- ✓ 120 teachers in physics and mathematics (gymnasium and high-school), of which: 60 physics teachers and 60 mathematics teachers;

From the 120 teachers we have: 60 teachers with seniority in education less than 10 years and 60 teachers with seniority in education more than 10 years.

3.3. Methods, techniques, instruments for research

The questionnaire for teachers was developed by the authors of the paper. This questionnaire had as objectives: theoretical and practical utility of existing textbooks and curriculums in physics discipline; the need for an interdisciplinarity between mathematics, physics and chemistry; the need to form a common trunk called the Science and of a specific textbooks. The questionnaire is constructed with 9 items from which 2 items are closed and 7 items are opened**.**

3.4. Analysis of statistic data

At the questionnaire were obtained the following results:

a) First item („Are you satisfied with the actual contents of the textbooks you use?") analysis of answers allows us to establish the fact that most teachers are dissatisfied by the current contents of the textbooks they are using. It notes that teachers of mathematics present a greater satisfaction than teachers of physics with the current content. In figure 1 we can find results obtained in the first item:

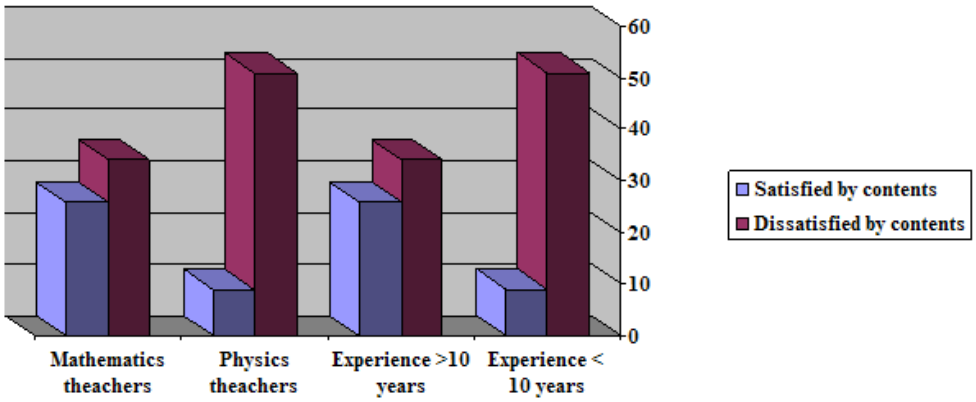

Fig. 1 – The number of the fulfilled and malcontent teachers with the content of actual textbooks.

From the response of teachers we have noted the following difficulties they face: the discrepancy curriculum-textbook, information still supreme, the essential

is not pointed, the creativity of students is not stimulated, lack of interdisciplinary vision, lack of exercises related to real life experiences; overload.

b) At 2.1 and 2.2 items ("Make a knowledge's essence" and "Emphasizes the habit – forming – educational character of the teaching-learning process") there were obtained the following percentage: 58.3% believes that through present contents of physics and mathematics textbooks is not carried out an essence of knowledge's and that they don't emphasize the habit-forming- educational character of the teaching-learning process.

Compared with the physics teachers that in percentage of 76.6% chose the answers "little" and "very little", the mathematics teachers 70% are fulfilled by the essence and by the habit-forming – educational character of content. Regarding the teachers with experience greater than 10 years have results near 45% and 55% toward the teachers with smaller experience 30.83% that are malcontent.

Figure 2 represents the data in percentages obtained from the teacher's answers at items 2.1 and 2.2:

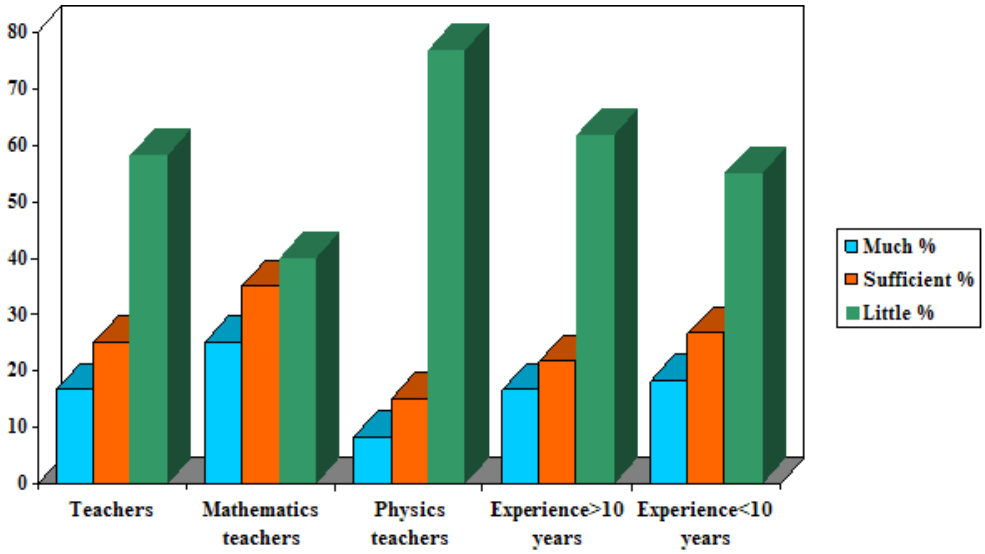

Fig. 2 – The brush-up and formation instructive character of the physics and mathematics textbooks.

c) At item 2.3 "We put the students in the situation to apply the theoretical knowledge's" most of the teachers, whatever the category they make part of, have the opinion that this theoretical knowledge's from textbooks oblige the student to apply them. Figure 3 shows the data obtained at this item.

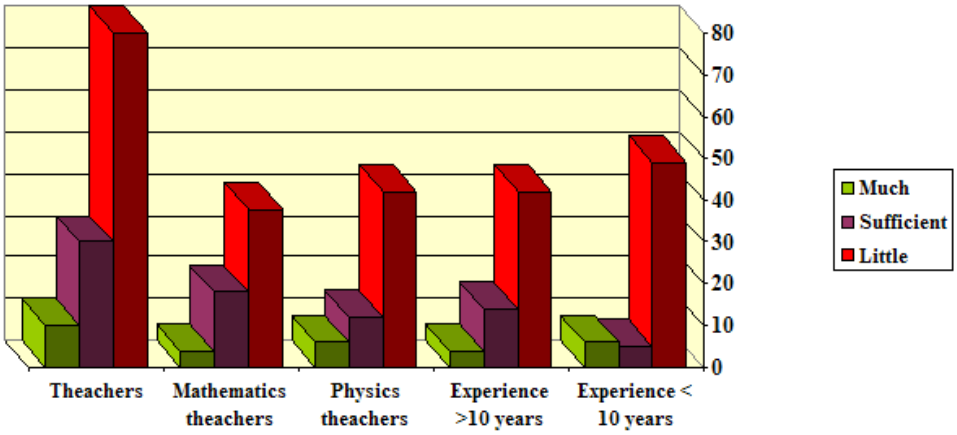

Fig. 3 – Practicability of theoretical knowledge's.

d) At 2.4 and 2.5 items ("Promote the interdisciplinarity in teaching-learning process" and "They are organized in a modular vision") we obtained the following results: 74.16% from teachers say that the curriculum does not incorporate an interdisciplinarity in the teaching-learning process and the also are not organised in a modular vision. The mathematics teacher (78.3%) as well as the physics teachers (70%), no matter the years of experience, chose the answers "little" and "very little".

In Fig. 4 are shown the results obtained at this item.

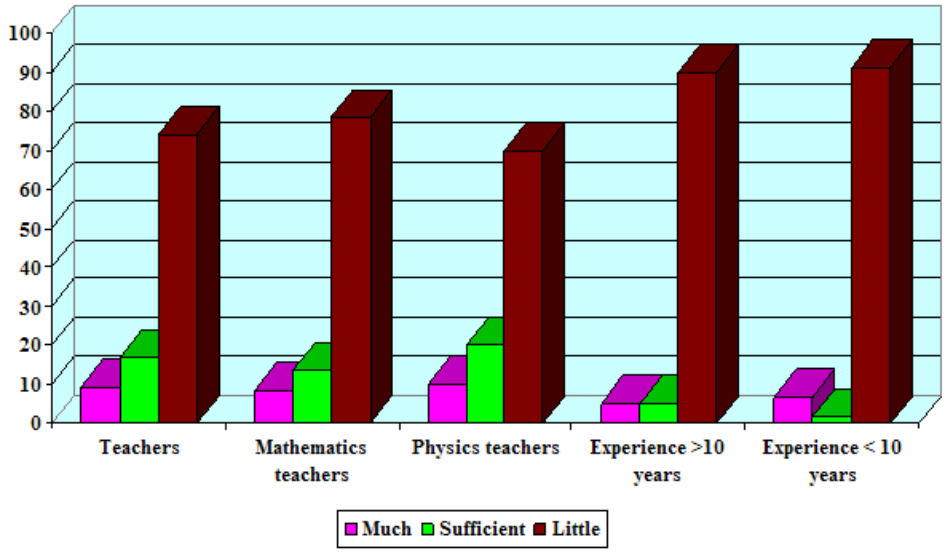

Fig. 4 – Interdisciplinarity in teaching-learning process and the modular vision of physics and mathematics knowledge's.

e) At item 3: "What difficulties do you find in teaching actual textbooks content?" after the statistical calculation it was obtained with approximation (59.16%) a majority for the answer "it is not related to the textbook content at interdisciplinary level".

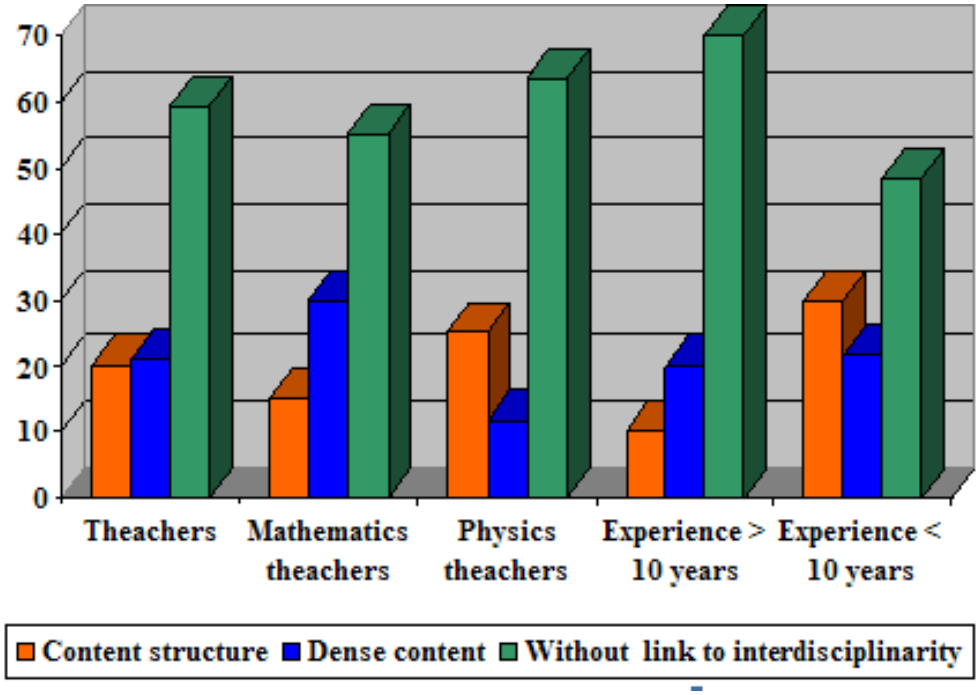

Fig. 5 – Difficulties in teaching.

f) Item 4: "Present three personal experiences that you know regarding the brush-up of knowledge's, promoting new contents; interdisciplinarity; modular organization; meetings on study objectives (interdisciplinarity)". We have the following types of answers with their relevant statistical calculation: hole chapters very little stated (50%) – variant 1; resolving problems in classroom (98.3%) – variant 2; it is hard for students to apply mathematics notions in physics (74%) – variant 3; teaching inclined plane without knowing at mathematics the trigonometry functions (67%) – variant 4.

Results in percentage obtained at item 4 are in Fig. 6:

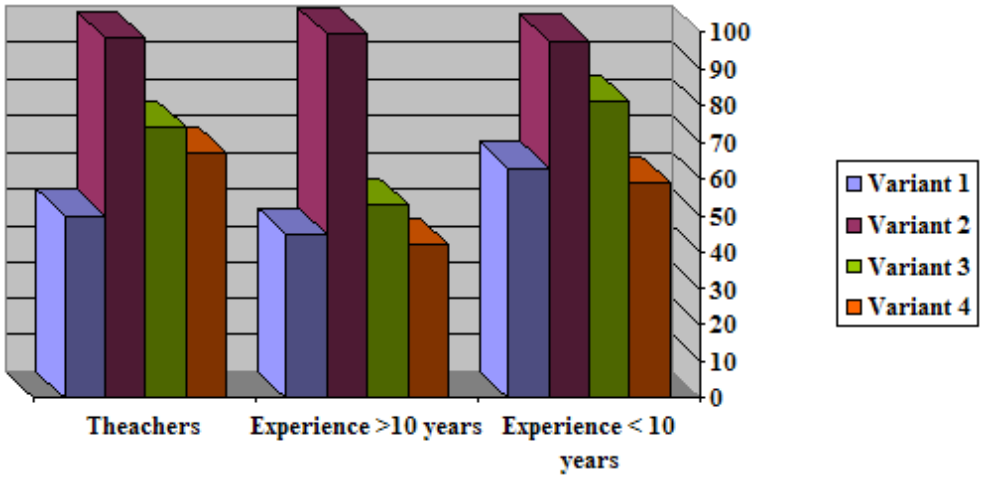

Fig. 6 – Personal experiences regarding the aspects stated in the above items.

g) At item 5 ("How much do you appreciate the necessity of some Science textbooks?"), from the 120 teachers 83.33% answered affirmatively and from them 33.3% were mathematics teachers and 50% physics teachers. The answers to this item are in Fig. 7.

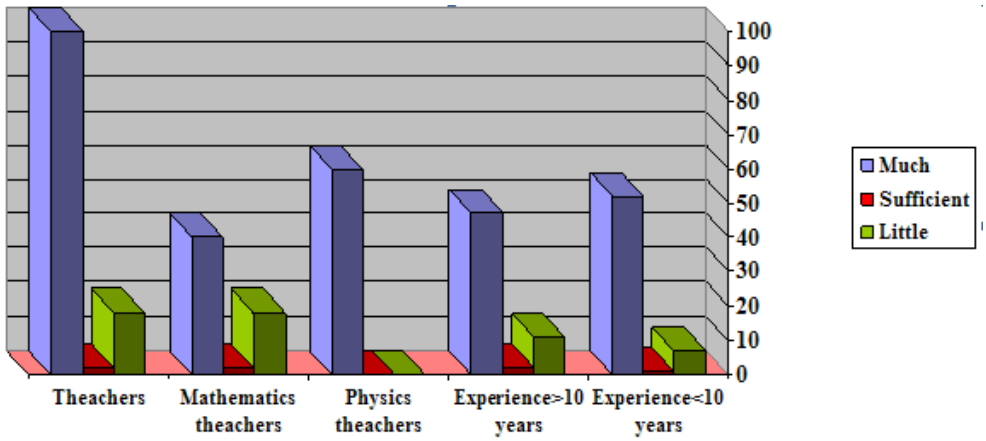

Fig. 7 – Requirement of some science textbooks.

h) At item 6 ("Suggest some criteria for elaboration of Science textbooks"), the criteria that had the biggest percentage (58.33%) after statistical calculation are: the modular interdisciplinary perspective – variant 1; to answer to students interests and needs – variant 2; ensures the brush-up of knowledges – variant 3; great graphics – variant 4.

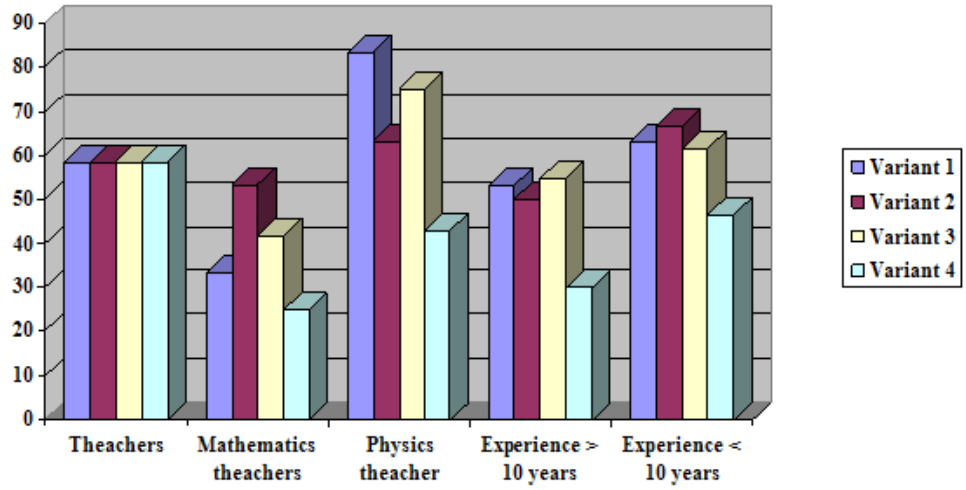

Fig. 8 – Variants of criterions for science textbooks.

i) Item: "What new problems should be found in new the textbooks?" At this item the most chosen items are variant b) (49.16%) („concerning for study and logical thinking") and variant c) (44.16%) („the content must have a bigger link between theory and practice") no matter the chosen categories.

In Fig. 9 you can find the teachers answers to item 7:

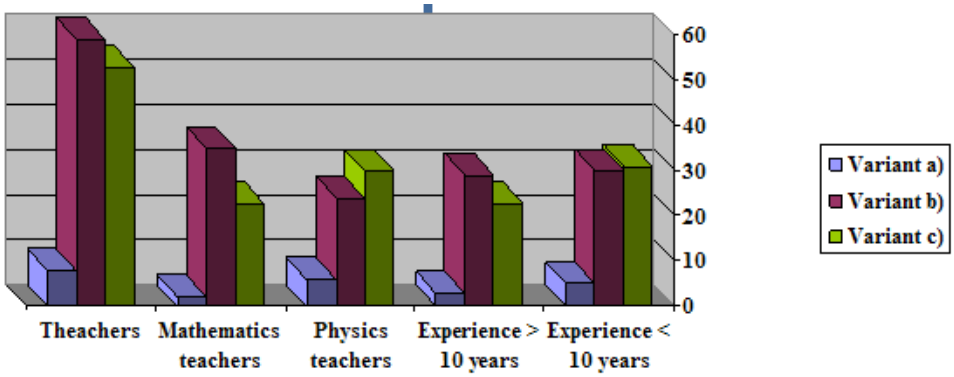

Fig. 9 – Types of problems available in the new textbooks.

j) Item 8: "Being at the cycle level that you teach, what should be the share of disciplines?"). Results show that approximately 80% has to represent binding disciplines, 20% to represent the optional disciplines, while 10% to represent at will disciplines. Figure 10 reflects results obtained at this item.

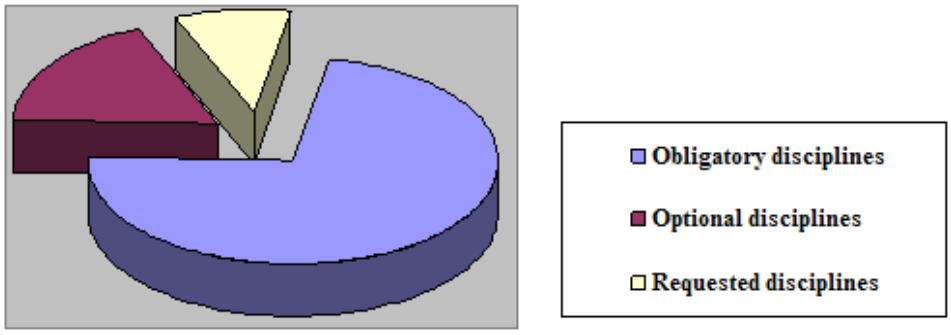

Fig. 10 – The share of disciplines in the education curriculum.

k) At the last item 9: ("State three suggestions regarding the reformation of high-school education contents"), we have the following answer variants: less and easier (82%) – variant 1; refreshing the school contents (75%) – variant 2; existence of a laboratory assistant and an endowment of physics-chemistry-biology laboratories in all the schools (98%) – variant 3; the discipline has to be teacher since I – IV classes (23%) – variant 4; agreement between mathematics and physics curriculums (88%) – variant 5.

In Fig. 11 you can find percentage results obtained at item 9:

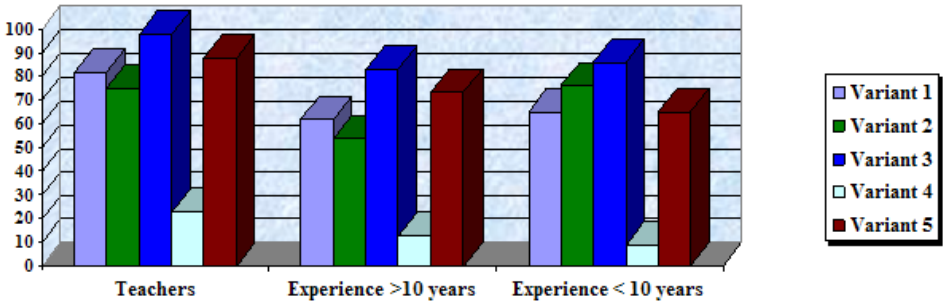

Fig. 11 – Suggestions regarding the contents reformation of the high-school education in the science curriculum area.

4. SUMMARY AND CONCLUSIONS

After experimental research and statistical data interpretation, we conclude:

1. Actual textbooks contents are non-adapted to the teaching needs of the teacher in an almost perfect and useful framework of the student. It is also known that at present the focus is more on theory and less on practical applications, the curriculum being over loaded and in the same time without ensuring consistency between the objects of study inside exact Science.

2. The experiment shows the possibility to apply interdisciplinarity and interdisciplinary demarche in high-school education.

3. An interdisciplinary education can be achieved through a complete curriculum, like an organization of education in which the student is placed at significant educational situations and performing activities that requires skills gained in many discipline at school.

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