Critical analysis of the Romanian Mathematics and Sciences school curricula based on the Romanian pupils' results on international testing

LILIANA CIASCAI, IULIANA MARCHIS

Psychology and Educational
Sciences Department
Babes-Bolyai University
Romania
liliciascai@yahoo.com
marchis_julianna@yahoo.com

ABSTRACT

Romania occupied a back position in the international tests on Mathematics and Sciences. Teachers stress out that one possible cause of this situation could be finding on the Mathematics and Sciences curricula. This paper presents the results of the comparisons of the Romanian curricula with the curricula promoted by the international testing (PISA 2000, 2003 and 2006, and TIMSS 1995, 1999, 2003, 2007) and the curricula of the countries occupied the first places in these tests. The comparisons underline those curricula approaches, which insure success on these tests and realize the reasons of the lack of success of the Romanian pupils. These results will be presented to the curriculum makers, universities and schools, to identify the specific and transferable competencies of the pupils with success in the above-mentioned disciplines.

KEYWORDS

Science Education, Mathematics Education, international testing, school curricula

RÉSUMÉ

La Roumanie se retrouve en bas du classement aux épreuves internationales de mathématiques et de sciences, selon les enquêtes internationales sur les compétences en mathématiques et en sciences acquises par les élèves. Les enseignants *roumains font l'hypothèse qu'on peut trouver des explications causales à cette situation dans les programmes d'enseignement de mathématiques et de sciences. Cet article présente les résultats d'une comparaison que nous avons menée entre les programmes roumains d'enseignement, les programmes promus par les enquêtes internationales (PISA 2000, 2003, 2006 ; TIMSS 1995, 1999, 2003, 2007) et les programmes mis en oeuvre par les pays qui occupent la tête du classement dans les enquêtes. Les comparaisons attirent l'attention sur les approches didactiques qui assurent la réussite aux tests et mettent en évidence les raisons du manque de succès des élèves roumains. Les conclusions de notre recherche seront présentées aux concepteurs du curriculum, aux universités et aux écoles, afin d'identifier les compétences spécifiques et transférables des élèves qui ont obtenu de bonnes performances aux disciplines mentionnées ci-dessus.*

MOTS-CLÉS

Enseignement des sciences, enseignement des mathématiques, épreuves internationales, curricula scolaires

Introduction

Romania's results on international testings PISA and TIMSS on Mathematics and Sciences remain constantly below the international average (Noveanu, Noveanu, Singer & Pop, 2002; p. 17-25; Noveanu, Noveanu, Singer, Tudor & Pop, 2002, p. 18-28; Gonzales, Guzmán, Partelow et al., 2004, p. 5, 19; Gonzales, Williams, Jocelyn et al., 2008, p. 7, 32; MEC, 2002, p. 12; OECD, 2007, p. 58, 318). These weak results have multiple causes, as the crowded and often changing curriculum, the weakly trained teachers, the uncertain quality textbooks, the insufficient of teaching materials, the lack of pupils' motivation for learning Mathematics and Sciences etc. (Miclea et al., 2007, p. 7). But the most important factor mentioned by the specialists and practitioners is the school curricula, which has an important role in orientation and/or organization of the learning process. (Schmidt et al., 1996, p. 15; Hook, 2005, p. 1; Schmidt, Houang & Cogan, 2002, p. 2; Noveanu, 2008, p. 25-37; Ciascai, 2009, p. 33; Marchis, 2009, p. 146). Thus in this article we propose to make a comparison between the 8th and 9th grade Mathematics and Sciences syllabi in Romania and the syllabi, which is on the base of the international testing. This comparison is extended to three countries, regularly situated on the top of the hierarchy after these tests: Chinese Taipei, Singapore and Finland.

THE POSITION OF ROMANIA AT PISA AND TIMSS TESTS

At international tests on the performance of pupils in Mathematics and Sciences, TIMSS 1995, 1999, 2003, 2007 and PISA 2000, 2003, 2006, Romania has a back position, having results below the international average.

For example, at the first TIMSS testing, in 1995, 41 countries have participated. The Romanian pupils have occupied the 33rd place at Mathematics and the 30th place at Sciences. At the last international testing, TIMSS 2007, the score in Mathematics and Sciences of 15 years old Romanian pupils doesn't have relevant changes from the previous results, obtaining even a lower average from both subjects than in the previous tests (see Table 1 and Table 2). With this average Romania occupied the 26th position at Sciences and the 28th position at Mathematics, while 48 countries have participated in the testing. Romanian students have obtained a higher position in the hierarchy than in the previous tests: the score of Romania has still situating under the international average.

On PISA tests Romanian pupils had similar results. Between the first PISA test and the last one the evolution of the Mathamatics and Science results was negative: if in 2000 the Mathematics score of Romanian pupils was 426 and the Science score 441, these decreased in 2006 with 11 point in case of Mathematics and 23 points in case of Sciences. From 57 participated countries in 2006 Romania ocupied the 45th position at Mathematics and the 47th position at Sciences, so back positions.

Analyzing the Mathematics results at TIMSS and PISA test, Romania has the score lower than the international average, with one exception: TIMSS 2003. On this testing Romania obtained 475 points, as the average is 466. The highest difference between Romania's score and international average was obtained at PISA 2006 test (see Figure 1). It is interesting to analyze the pupils' results regarding the levels of Bloom's taxonomy. The chose of this taxonomy is motivated by the fact that it is well known equally by specialists and practitioners.

For example, at TIMSS 2007 three levels of the Bloom's cognitive taxonomy were analyzed: knowing, applying, reasoning. In Figure 2 the results divided to these levels are given for the first five countries and for Romania are given. We could observe that for Romania the difference between "applying" and "reasoning" cognitive level is the biggest among the presented countries. In case of Chinese Taipei the score for these three levels are similar, as for Japan the score for reasoning is highest than the other two scores.

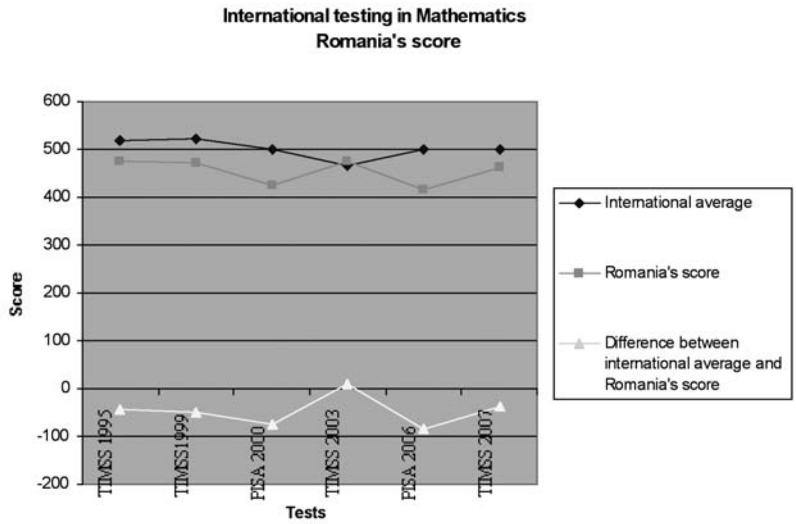
TABLE 1

The results of Romanian students at international tests in Mathematics

[Noveanu, Noveanu, Singer & Pop, (2002), p. 17-20; Noveanu, Noveanu, Singer, Tudor & Pop, (2002), p. 18-22; Gonzales, Guzmán, Partelow et al., (2004), p. 5, Gonzales, Williams, Jocelyn et al., (2008), p. 7; MEC, (2002), p. 12; OECD, (2007), p. 318]

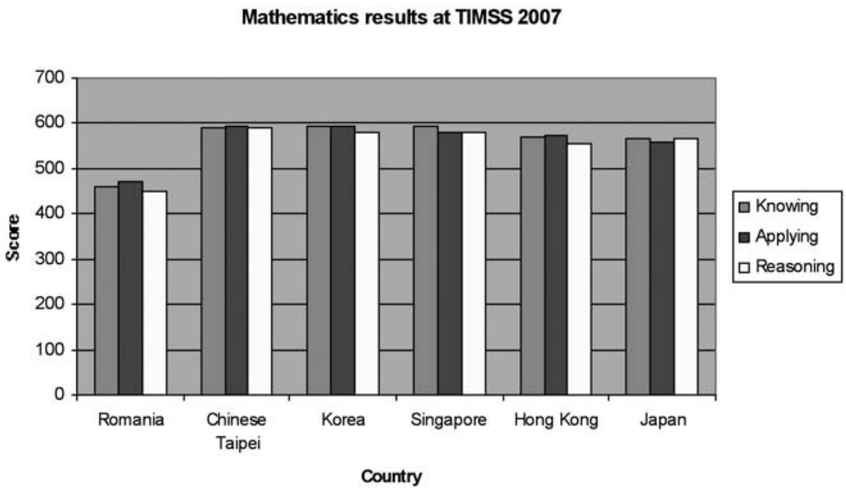
TIMSS tests			PISA tests		
Year	**TIMSS average**	**Romania's score**	**Year**	**OECD average**	**Romania's score**
1995	519	474	2000	500	426
1999	521	472	2003	500	-
2003	466	475	2006	500	415
2007	500	461			

FIGURE 1



The results of Romanian students at international tests in Mathematics [Noveanu, Noveanu, Singer & Pop, (2002), p. 17-20; Noveanu, Noveanu, Singer, Tudor & Pop, (2002), p. 18-22; Gonzales, Guzmán, Partelow et al., (2004), p. 5, Gonzales, Williams, Jocelyn et al., (2008), p. 7; MEC, (2002), p. 12; OECD, (2007), p. 318]

FIGURE 2



The Mathematics results at TIMSS 2007 by cognitive levels [Noveanu, Noveanu, Singer & Pop, (2002), p. 17-20; Noveanu, Noveanu, Singer, Tudor & Pop, (2002), p. 18-22; Gonzales, Guzmán, Partelow et al., (2004), p. 5, Gonzales, Williams, Jocelyn et al., (2008), p. 7; MEC, (2002), p. 12; OECD, (2007), p. 318]

As regarding Romania's results on Science, it always situated under the international average (Table 2). The highest difference was recorded at PISA 2006 (Figure 3).

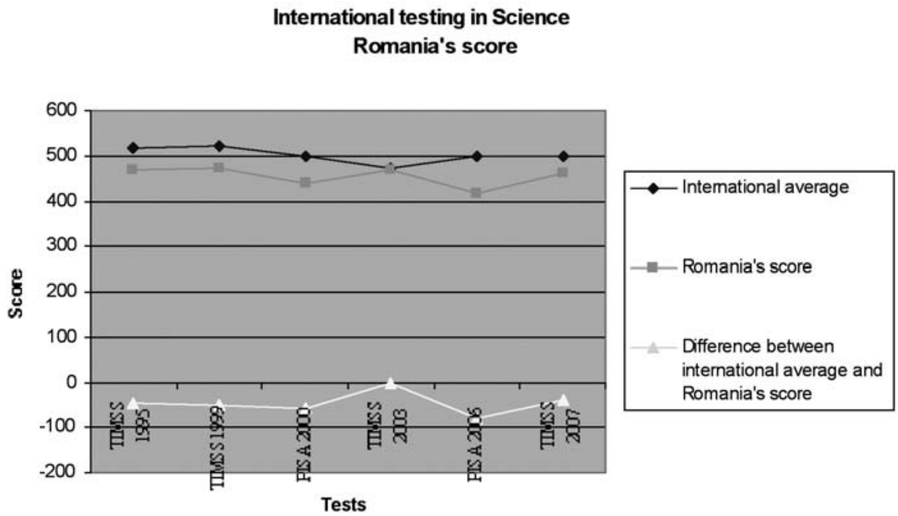
TABLE 2

The results of Romanian students at international tests in Sciences

[Noveanu, Noveanu, Singer & Pop, (2002), p. 21-25; Noveanu, Noveanu, Singer, Tudor & Pop, (2002), p. 23-28; Gonzales, Guzmán, Partelow et al., (2004), p. 19, Gonzales, Williams, Jocelyn et al., (2008), p. 32; MEC, (2002), p. 12; OECD, (2007), p. 58]

TIMSS tests			PISA tests		
Year	**TIMSS average**	**Romania's score**	**Year**	**OECD average**	**Romania's score**
1995	518	471	2000	500	441
1999	521	472	2003	500	-
2003	473	470	2006	500	418
2007	500	462			

Figure 3



The results of Romanian students at international tests in Sciences [Noveanu, Noveanu, Singer & Pop, (2002), p. 21-25; Noveanu, Noveanu, Singer, Tudor & Pop, (2002), p. 23-28; Gonzales, Guzmán, Partelow et al., (2004), p. 19, Gonzales, Williams, Jocelyn et al., (2008), p. 32; MEC, (2002), p. 12; OECD, (2007), p. 58]

The most common explications of these mediocre results given by teachers, parents and pupils are related with the content of the school curriculum, underlining the differences between goals and topics (Noveanu, 2008, p. 25-37; Vlaston, 2008).

Trends in International Mathematics and Science Study (TIMSS) Curricula

TIMSS represents a series of studies conducted by the International Association for the Evaluation of Educational Achievement (IEA), by the TIMSS & PIRLS International Studies Center. Created in 1959, the IEA has conducted many studies of cross-national achievement in curricular areas such as Mathematics, Science, Language, Civics, and Reading. TIMSS data on the Mathematics and Science achievement of U.S. 4^{th} and 8^{th} grade students, compared to that of students in other countries, have been collected in 1995, 1999, 2003, and 2007.

The curricula proposed by TIMSS 1995 and TIMSS-R 1999 for the fields of Mathematics and Sciences have evaluated contents, performance, values and attitudes as well (Martin & Kelly, 1997). The competencies evaluated on these tests were *understanding* *theorizing, analyzing, solving problems*; *using tools, routine procedures, and science processes*; *investigating the natural world*; *communicating in the language of mathematics and of sciences*.

In 2003 TIMSS has identified three cognitive domains according to how the students are expected to act or type of cognitive activity required, to reach a correct response in Mathematics and Sciences (Mullis et al., 2001):

- *Factual knowledge*: students have to demonstrate knowledge of relevant facts in the fields of Mathematics and Sciences, information, tools and procedures;
- *Conceptual understanding (in Sciences) respectively using concepts and solving routine problems (in Mathematics):* students must be able to extract and use scientific and mathematical concepts and principles to find solutions, support of statements of facts or concepts, demonstrate relationships, equations and formulas. These operations require mainly application of knowledge and understandings.
- *Reasoning and Analysis (in Sciences) and reasoning (in Mathematics):* students were challenged to solve more complex problems, to develop explanations, to draw conclusions, to evaluate, to make decisions, to design experiments and procedure. In fact, students have to extend their knowledge to new situations (sometimes by connecting knowledge and understanding from different areas and apply it to new situations) based on their conceptual understanding.

At the testing from 2007 also three cognitive domains were identified and tested: Knowing, Applying and Reasoning. The first domain includes knowledge that students have to posses about the science (facts, concepts, laws etc.), the second one could be dividing in two sub-categories: applying knowledge (identifying, extracting and relating knowledge, interpreting facts and dates etc.) and conceptual understanding involved in problem solving or in answering to problem questions. *Reasoning concern* cognitive processes involved *in solving complex problems and tasks (*Martin, Mullis & Foy, 2008, p. 113; Mullis et al. 2008, p. 117).

In the 2007 TIMSS testing the accent was on the scientific and mathematical skills of pupils, for example the *Knowing* domain doesn't describe knowledge (contents) but key skills: "making or identifying …", "recognizing and using…", "describing …" etc. In consequence TIMSS testing covers the knowledge, understanding and reasoning and application levels from Bloom's cognitive taxonomy.

The Curricula of OECD's Program for International Student Assessment (PISA)

The Organization for Economical Cooperation and Development (OEDC) has conducted three tests in 2000, 2003 and 2006 in the context of the international research program on the pupils' performance (PISA). The main goal of these tests was to obtain information about the objectives of the educational policies and the instruction methods, which develop useful competencies in the adult life: the capacity to extrapolate and apply the knowledge in new, original, and non-scholar situations. The interest of pupils on learning has been also evaluated, and information on the learning context of pupils' (family, educational institution) has been collected, context, which could explain differences in performance.

The main target group was the group of 15 years old pupils (from 15 years and 3 months old to 16 years and 2 months old).

The PISA testing in 2003 has evaluated for the first time the transdisciplinar competencies of 15 years old pupils, introducing the *Scientific and Mathematical Literacy* concepts, defined as follows:

- *The Scientific Literacy:* The capacity to use scientific knowledge, to identify scientific questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (OECD, 2003). It requires understanding of scientific concepts, an ability to apply a scientific perspective and to think scientifically about evidence.
- *The Mathematical Literacy:* The capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen" (OECD, 2003). It is related to wider, functional use of mathematics, engagement requires the ability to recognize and formulate mathematical problems in various situations.

The assessment areas covered by PISA 2003 (OECD, 2004) refer to:

- the *content and structure* of knowledge that students need to acquire in each assessment area (e.g., familiarity with mathematical concepts);
- the *processes* that need to be performed (e.g., pursuing a certain mathematical argument);
- the *situations* in which students encounter mathematical problems and relevant knowledge and skills are applied (e.g., making decisions in relation to one's personal life, or understanding world affairs).

Mathematics was the major domain assessed in PISA 2003. As consequence, the assessment of mathematical literacy by PISA 2006 was less comprehensive than the science assessment. PISA 2006 preserved the definition of *mathematical literacy* introduced in 2003, putting the accent on the individual "an individual's capacity to identify and understand the role …" (OECD, 2007).

Science was the major domain in PISA 2006. The concept of scientific literacy was reviewed in PISA 2006 test, being defined in terms of individual's: scientific knowledge and use of the knowledge as an instrument to acquire new knowledge; understanding science as a form of human knowledge and enquiry; awareness of science role in developing our society (*how science and technology shape our material, intellectual and cultural environments*); willingness to engage with science-related issues, and with the ideas of science, as a reflective citizen (OECD, 2007, p. 34-35).

PISA 2006 testing has divided the scientific knowledge in two categories: *Knowledge from Science* and *Knowledge about Science* (OECD, 2007, p. 37). The first category's content is centered on systems: Physical systems; Living systems; Earth and Space systems; Technology systems (OECD, 2007, p. 38). The second one concentrates on the scientific knowledge process: scientific enquiry (Origin; Purpose; Experiments; Data; Measurement; Characteristics of results) and scientific explanations (Types; Formation; Rules; Outcomes). (OECD, 2007, p. 39).

The attitudes considered at PISA tests concern scientific knowledge and education trough science (OECD, 2007), those important for a researcher: support for scientific enquiry**,** self-belief as science learner, interest in science; responsibility towards resources and environments. (OECD, 2007, p. 39). The scientific contexts investigated by PISA 2006 were the familial context, natural resources, the quality of the environment, risks, the frontiers of sciences and technology.

In consequence, PISA 2006 testing was realized on the base of important curricular reviews.

The Mathematics anc Science Curricula of Countries Having First Position in International Testing

In this study we refer to the Mathematics and Science curricula of the countries situated in the first places in the most recent international testing: TIMSS 2007 and PISA 2006.

Chinese Taipei has occupied the first place at Mathematics and the second place at Sciences at TIMSS 2007.

Analyzing the scope of learning Mathematics in Chinese Taipei we observe the preoccupation for developing an abstract and algorithmic thinking, word problem-solving skills and abilities to learn in this domain. The attitudes concerned are about developing the following: pupils should see the beauty of Mathematics (Mullis et al., 2008).

As regarding learning Sciences, in Chinese Taipei the curricular orientations are similar with those concerned by PISA 2006. Thus, the accent is equally on knowledge from Science (science process skills, development of scientific attitudes etc.) and about Science (e.g. understanding the nature of science). Also the interest of developing scientific attitude is expressed.

Singapore was the first at Sciences and the third at Mathematics at TIMSS 2007.

The Mathematics secondary school curriculum from Singapore is centered on acquisition of those mathematical concepts, which are necessary in everyday life and on development of mathematical thinking, problem solving skills, communication skills in the domain of Mathematics and a positive attitude towards learning Mathematics.

The Sciences curriculum (Mullis et & al., 2008) concerns the knowledge and understanding of the scientific language, fact, concepts, ideas and scientific instruments, development of scientific thinking, investigation skills and scientific problem solving skills, cultivation of ethical attitudes and behavior, which assure the scientific process. The main interests concern the development of scientific knowledge, abilities and attitudes in contexts as science in daily life, science in society and science and the environment. These domains near the Science curriculum from Singapore to the curriculum on which the international testing is based.

Finland occupied the first place in Mathematics and Sciences at the PISA 2006 testing. Malaty (2007, p. 421) enumerates six reasons for success of Finland at international testing: the successful pre-service teacher education, the culture of the teacher profession, the effective in-service teacher education, the development of the Mathematics Education, the daily traditions of school-life and the continuity of teachers' work. Bjorkqvist (2005) also underlined, that there is no one reason for the good results of Finland on the international tests, but there is a collection of factors that contributed towards the success. Among these factors the system of in-service and pre-service teacher education is an essential one.

Finnish Science curriculum emphasizes the nature of a teaching/learning process. The analysis of the goals formulated for Physics and Chemistry education from 7th grade to 9th grade permits the identification of many similarities with the goals formulated for the international tests. Thus in the Finland curricula the accent is put on the acquisition of a set of scientific skills as formulation of questions, perception of problems, construction and testing of hypothesis, planning and carried out a scientific investigation, construction of models and using them to explain phenomena, problem solving etc. (Lavonen, 2006, p. 6). These goals are not only stated, but also applied in practice. For example, Lavonen (2006) specifies that teaching Science and Chemistry starts with the investigation of the pupils' empirical knowledge, prior skills, and experiences acquired by their acting in nature. The construction of the scientific knowledge is made based on these prior findings. In this construction of the new knowledge experimental activity has an important place. Experiments involve students in physical (hands on) and mental activity (mind on), and help students "*to perceive the nature of science and (ii) to learn new scientific concepts, principles, and models; (iii) to develop skills in experimental work and (iv) cooperation; and (v) to stimulate the pupils to study physics and chemistry (interest)*" (Lavonen, 2006, p. 4). As it could be concluded from these considerations, the Finish Science curriculum has a very clear perspective concerning students' acquisitions in Science and teachers apply successfully these considerations in practice.

As regarding Mathematics Education, the Mathematics school curriculum has radically changed several of times in the last decades. Since the 1980's problem solving becomes one of the most important goal of Mathematics education (Kupari, 1999). "*Solving problems is not only a goal of learning mathematics but also a major means of doing so. … In everyday life and in the workplace, being a good problem solver can lead to great advantages. … Problem solving is an integral part of all mathematics learning.*" (NCTM, 2000, p. 52). In Finland the policy makers realized, that changing the curriculum is not enough to change the educational results, so they put an accent on problem solving in pre-service teacher training, too. Also they organize seminars to help in-service teachers to implement the new curriculum in an effective way. Textbooks based on problem solving were written. For example, the mathematics textbook for grades 7–9 "Matka matematiikkaan" [A Journey to Mathematics] (Espo & Rossi, 1996) was launched. The focus in this textbook is teaching mathematics via problem solving, i.e. almost all contents are introduced using proper problem situations. Pehkonen (2008) studied how Finnish teachers implement problem solving in their classes and arrives to the conclusion that teachers in Finland are changing in the direction of a more favorable attitude to problem solving. Since 1990 the Mathematics curriculum in Finland puts accent on everyday life Mathematics.

METHODOLOGY

In this analysis, realized on the Mathematics and Science curricula in Romania, we refer to the secondary school syllabi for 15 years old pupils, this age being concerned at international tests. The analysis made on the school syllabi considers original Bloom's taxonomy of the cognitive domain, adapted for Mathematics and Science:

- Knowledge (know scientific facts, concepts, method and basic principles);
- Comprehension (understand scientific concepts, interpretate scientific principles, translating symbolic representations, make inferences from observations of phenomena and/or events, estimate consequences based on findings or data, justifying procedures in a process, explain or illustrate why a solution is correct, etc.)

- Application (apply of scientific concepts and theories to explain phenomena and processes, construct graph from data, use the scientific procedures in new situations, organize data, choose appropriate information and solve a problem quantitatively, etc.)
- Analyses (identify patterns and trends, identify a conceptual model based on a given set of data, identify assumptions in a scientific proposition, recognize fallacies in an argument, analyze the structure of a scientific investigation, etc.)
- Synthesis (draw conclusions, compare two competing theories applied to an issue, propose procedures for solving a problem, integrate principles from different branches of science, plan and develop an investigation starting from a problem or hypothesis, etc.)
- Evaluation (evaluate conclusions based on scientific data, judge the adequacy of an hypothesis or theory to explain a phenomena, compare solutions to a problem by taking in consideration their strong and weak points etc.) (Bloom, 1956).

Taking in account students' cognitive level and underlining some scientific aspects, we made some modifications. Knowledge and understanding were grouped together, as they need simple cognitive operations on the acquired knowledge. Investigation and modeling were placed on the application level (although generally they are mentioned on superior levels) because in the analyzed school syllabi these two are referred as transfer of knowledge in new situations (for example making experiments following some given steps, realizing observations based on some criteria, using a model for investigations or illustration of a process etc.).

The core-competencies from Mathematics and Sciences curricula are presented in Table 3.

TABLE 3

Core competencies in 5th to 9th grade Mathematics and Sciences curricula (CNC, 2003; CNC, 2004)

	MATHEMATICS	PHYSICS, CHEMISTRY AND BIOLOGY
Knowledge, understanding	Knowledge and understanding of the concepts, terminology and calculation procedures specific for Mathematics (grades 5th to 8th); Identification of data and mathematical relations and correlation of them in function of the context in which they	Knowledge and understanding of phenomena (Physics, Chemistry), of specific terminology and concepts (Physics, Chemistry, Biology), of the specific methods from Physics and specific principles of Biology (grades 5th to 8th); Reception of information about

TABLE 3

Core competencies in 5th to 9th grade Mathematics and Sciences curricula (CNC, 2003; CNC, 2004)

	MATHEMATICS	PHYSICS, CHEMISTRY AND BIOLOGY
	have been defined (9th grade);	the living world (9th grade); Understanding and explaining of some Physics phenomena, of some technological processes, of the operation and use of technology products found in everyday life (Physics, 9th grade); Explanation of some phenomena, processes, procedures found in everyday life (Chemistry, 9th grade);
Investigation	Development of the ability of exploration/ investigation and problem solving (5th to 8th grades);	Development of the capacity to explore/investigate the reality (Physics, Chemistry, Biology), to do experiments using specific instruments and procedures (Physics), to solve specific problems for Chemistry and Biology (5th to 8th grades); Application of scientific experimental and theoretical investigation in Physics; Investigation of some chemical substances or systems (9th grade); Exploration of biological systems (9th grade);
Modeling	Utilization of algorithms and mathematical concepts to characterize local or global concrete situation (9th grade); Mathematical modeling of various problem contexts integrating knowledge from different domains (9th grade);	Utilization and construction of models and algorithms in order to prove the principals of the living world (Biology) (9th grade);
Analyzing, Transferring & Integrating	Analyzing and interpreting the mathematical characteristics of a problem (9th grade);	Development of the capacity to analyze and to solve problems (Physics, 6 to 8 grades); Transferring and integrating biological knowledge and methods in new contexts (Biology, 9th grade);

Table 3

Core competencies in 5th to 9th grade Mathematics and Sciences curricula (CNC, 2003; CNC, 2004)

	Mathematics	Physics, Chemistry and biology
Processing data/ Solving problems	Processing quantitative, qualitative, structural and contextual data from mathematical problems (9th grade); Expression of quantitative or qualitative mathematical characteristics of a concrete situation and the algorithms for processing these data (9th grade);	Solving problems to establish relevant correlations using deductive and inductive reasoning (Chemistry) (9th grade);
Evaluation		Evaluation of consequences of processes and actions of the chemical products on their own person and the environment (Chemistry) (9th grade);
Communication	Development of the capacity to communicate on the mathematical language (5th to 8th grades);	Development of the capacity to communicate using the specific language for Physics/Chemistry/ Biology (5th to 8th grades); Communication (Physics, 9th grade); Communication of understanding concepts in solving problems, formulating explanations, in conducting investigations, and in reporting results (Chemistry, 9th grade); Oral and written communication using the specific biological terminology (9th grade);
Attitudes	Development of the interest and motivation to study and apply mathematics in various contexts. (5th to 8th grades).	Formation of critical attitudes towards the effects of Science on development of Technology and of the society, raising the interest toward the protection of the environment (Physics) (5th to 8th grades); Development of values and attitudes regarding the impact of Chemistry and Biology on nature and society (5th to 8th grades). Protection of their own person, of the others and the environment (Physics, 9th grade).

In order to offer a global perspective on the content of the Mathematics and Science school syllabi, we presented in the same table not only the competences grouped based on the Blooms' taxonomy, but also the communication competence and attitudes.

Critical Analysis of the Romanian Science and Mathematics Curricula

In Table 3 we observe that the main preoccupations of the curriculum developers are concerning on knowing concepts and mathematical relations, constructing and applying algorithms for processing data. Mathematical communication and development of children' motivation for learning Mathematics are present in the curriculum, but doesn't have an important role. The analysis of Mathematics curriculum for 8th grade has shown that it stops at the analysis level of the cognitive domain taxonomy of Bloom, without covering the synthesis. The curriculum for 9th grade is similar to those of secondary school curricula, in addition requires only the integration of knowledge from various fields. Curriculum in Singapore, for example, which is based on international tests, specific the need for carrying out imaginative and creative works.

Science curricula address the levels of Bloom's taxonomy of cognitive domain in an extremely unequal way. For example, the competence of analysis and problem solving is listed only in the Physics curriculum for 8th grade. Shouldn't the students be involved in analysis and problem solving at Chemistry and Biology classes? The authors of the Chemistry curriculum for 9th grade have introduced this competence, those of the Physics curriculum have withdrawn it, as the authors of the Biology curriculum continues to omit it, but instead they have introduced the competence to do modeling. Also, in the Chemistry curriculum appears a reference to the evaluation level of the Bloom's taxonomy (evaluating the consequences ...). Modeling appears only in the Biology curriculum. This omission is serious as in Science the model represents an interface with the nature and modeling is an important tool for knowledge. In consequence, the construction and utilization of models is an important scientific competence and should be an important goal for Science teaching. In fact, the analysis of the Science curriculum shows the fact that the authors have ignored that students must possess, in addition to the knowledge of science and knowledge from science, series of scientific thinking skills. A positive aspect of these curricula is the references to the everyday life of the students.

Another aspect, which has to be mentioned, related with the curricula is the distribution of the competencies for study years. Every school curricula should be constructed spirally as regarding the competencies and contents. This principle orientates the deepening of the knowledge from a study year to the next one. In case of Science curricula in Romania this principle is not totally respected. For example, the competence "Reception of information about the living world" (9th grade) can't succeed an "understanding" type competence formulated in 5-8 grades. Also in case of the Physics curricula, if pupils should be able to make experiments in 6-8 grades, in 9th grade they should have been expected to design experiment, not only to apply the experimental method for developing knowledge.

Conclusion

Romanian students obtain outstanding results at the international Olympiads of Mathematics and Science every year. We enumerate some results in the followings. On International Mathematics Olympiad in 2006 Romania obtained the 6th place among 90 participating countries (winning 3 gold, 1 silver, 2 bronze medal); in 2007 the 11th place among 93 participating countries (1 gold, 4 silver, 1 bronze); 2009 the 13th place among 104 participating countries (2 gold, 2 silver, 2 bronze) (IMO 2006, IMO 2007, IMO 2009). On International Physics Olympiad in 2008 Romania won 1 gold, 3 silver, 1 bronze medals (IPhO 2008); at International Chemistry Olympiad in 2003 won 1 gold, 1 silver, and 2 bronze; in 2008 obtained 3 silver and 1 bronze medals (IChO 2003, IChO 2008).

However at the masses, the results are sub mediocre, in the view of the international tests. Analysis of Mathematics and Science curricula shows superficial concerns of the authors of the curriculum in Romania for training and development of those skills and competencies which are tested on the international tests or which are present in the curricula of successful countries on these tests. It also shows lack of concern to remedy the situation by reconsidering existing palette of skills, which are important to be developed. In conclusion, the effort of adapting the Romanian curriculum to the international ones should be a priority of Mathematics and Science Education.

Curricula of these subjects are only one cause of this situation; there are many other possible factors mentioned in the introduction.

A future research is concerned on studying the influence of these factors on the results of Romanian pupils on international tests.

References

Bjorkqvist, O. (2005). Mathematics education in Finland – what makes it work? In Proceedings of Conferences of "The Mathematics Education into the 21st Century Project", 45-48.

Bloom B. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain* (New York: David McKay Co Inc).

Ciascai, L. (2009). Comparative study on Romanian School Science curricula and the curriculum of TIMSS 2007 testing. *Acta Didactica Napocensia,* 2(2), 25-34

CNC (2003). *Programa şcolară revizuită de fizică. Clasele a VII-a si a VIII-a (Reviewed Physics syllabus for 7th and 8th grade)* (Bucureşti: MECT).

CNC (2003). *Programa şcolară revizuită de biologie. Clasele a VII-a si a VIII-a (Reviewed Biology syllabus for 7th and 8th grade)* (Bucureşti: MECT).

CNC, 2003. *Programa şcolară revizuită de chimie (Reviewed Chemistry syllabus for 7th and 8th grade). Clasele a VII-a si a VIII-a* (Bucureşti: MECT).

CNC (2003). *Programa şcolară revizuită de matematică. Clasele a VII-a si a VIII-a (Reviewed Mathematics syllabus for 7th and 8th grade)* (Bucureşti: MECT).

CNC (2004). *Programa şcolară de clasa a IX-a. Ciclul inferior al liceului. Biologie (Biology syllabus for 9th grade)* (Bucureşti: MECT).

CNC (2004). *Programa şcolară de clasa a IX-a. Ciclul inferior al liceului. Chimie (Chemistry syllabus for 9th grade)* (Bucureşti: MECT).

CNC (2004). *Programa şcolară de clasa a IX-a. Ciclul inferior al liceului. Fizică (Physics syllabus for 9th grade)* (Bucureşti: MECT).

CNC (2004). *Programa şcolară de clasa a IX-a. Ciclul inferior al liceului. Matematică (Mathematics syllabus for 9th grade)* (Bucureşti: MECT).

Espo, K. & Rossi, M. (1996). *Matka matematiikkaan – oppikirjasarja (A journey to mathematics – a textbook series)* (Helsinki: Edita).

Gonzales, P., Guzmán, J. C., Partelow, L., Pahlke, E., Jocelyn, L., Kastberg, D. & Williams T. (2004). *Highlights from the Trends in International Mathematics and Science Study (TIMSS) 2003* (NCES 2005–005) (U.S. Department of Education, National Center for Education Statistics) (Washington, DC: U.S. Government Printing Office).

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D. & Brenwald, S. (2008). *Highlights from TIMSS 2007: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context* (NCES 2009–001) (U.S. Department of Education, National Center for Education Statistics) (Washington, DC: U.S. Government Printing Office).

Hook, W. (2005). *"Curriculum Makes a Huge Difference" – A Summary of Conclusions from the Trends in International Mathematics Study (TIMSS) with California Data Added*, (http://www.nychold.com/report-hook-040305.pdf).

IChO (International Chemistry Olympiad) (2003). http://www.35icho.uoa.gr/ichol_eng/index_eng.htm.

IChO (International Chemistry Olympiad). (2008). http://www.icho.hu/pages/40thOlympiad.aspx.

IMO (International Mathematics Olympiad) (2006). http://imo2006.dmfa.si/results_ctd.html.

IMO (International Mathematics Olympiad) (2007). http://www.imo2007.edu.vn/.

IMO (International Mathematics Olympiad) (2009). http://www.imo2009.de/.

IPhO (International Physics Olympiad) (2008). http://ipho2008.hnue.edu.vn/.

Kupari, P. (1999). *Laskutaitoharjoittelusta ongelmanratkaisuun. Matematiikan opettajien matematiikkauskomukset opetuksen muovaajina*. (*From practising computational skills to problem solving. Mathematics teachers' mathematical beliefs and the construction of their teaching*) (Research Reports 7) (Institute for Educational Research: University of Jyväskylä).

Lavonen, J. (2006). *National Science Education Standards in Finland* (IPN - UYSEG Science Education Symposium: Standards in Science Education).

Malaty, G. (2007). *PISA Results and School Mathematics in Finland: strengths, weaknesses and future*. In Proceedings of Conferences of the Mathematics Education into the 21st Century Project, 420-424.

Marchis, I. (2009). Comparative analysis of the mathematics problems given at international tests and at the Romanian national tests. *Acta Didactica Napocensia*, 2(2), 141-148.
Martin, M. O., Mullis, I. V. S. & Foy, P. (2008). *TIMSS 2007 International Science Report: Findings from IEA's trends in International Mathematics and Science Study at the Fourth and Eighth Grades* (Lynch School of Education, Boston College: International Study Center IEA).
Martin, M. O. & Kelly, D. L. (1997). *Technical report volume II: Implementation and analysis* (Chestnut Hill, MA: TIMSS International Study Center).
MEC (2002). *PISA 2000. Programul Internaţional OECD pentru evaluarea elevilor. Raport naţional* (http://administraresite.edu.ro/index.php/articles/4747).
Miclea, M., David, D., Funeriu, D., Florian, R., V., Ciuparu, D., Ionac, M., Luchian, T., Banabic, D., Iucu, R., Frangopol, F. T., Vlăscanu, L. & Barzea, C. (2007). *România educaţiei, România cercetării. Raportul Comisiei Prezidenţiale pentru analiza şi elaborarea politicilor din domeniile educaţiei şi cercetării.* Bucureşti.
Mullis, I. V. S., Martin, M. O., Smith, T. A., Garden, R. A., Gregory, K. D., Gonzales, E. J., Chrostowski, S. J. & O'Connor, K. M. (2001). *TIMSS assessment frameworks and specifications 2003* (Lynch School of Education, Boston College: International Study Center IEA).
Mullis, I. V. S., Martin, M. O., Olson, J. F., Berger, D. R, Milne, D. & Stanco, M. G. (2008). *TIMSS 2007 Encyclopedia: A Guide to Mathematics and Science Education Around the World (Volume 2)* (Lynch School of Education, Boston College: International Study Center IEA), 113-116.
NCTM (2000). *Principles and Standards for school mathematics* (Reston, VA: National Council of Teachers of Mathematics).
Noveanu, G., Noveanu, D., Singer, M. & Pop, V. (2002). *Învăţarea matematicii şi a ştiinţelor naturii. Studiu comparativ (1)* (Bucureşti, S.C: Aramis print S.R. L., Consiuliul Naţional pentru Curriculum), 21-25.
Noveanu, G., Noveanu, D., Singer, M., Tudor, V. & Pop, V. (2002). *Învăţarea matematicii şi a ştiinţelor naturii. Studiu comparativ (2)* (Bucureşti, S.C. Aramis print S.R. L., Consiuliul Naţional pentru Curriculum), 23-28.
Noveanu, G. (2008). *Curriculum intenţionat – Curriculum realizat: studiu comparativ (disciplina chimie), din perspectiva datelor TIMSS.* Teză de doctorat, Bucureşt.
OECD (2003). *The PISA 2003 Assessment Framework – Mathematics, Reading, Science and Problem Solving Knowledge and Skills* (Paris: OECD).
OECD (2004). *PISA 2003. Learning for Tomorrow's World. First Results from PISA 2003* (Paris: OECD).
OECD (2007). *PISA 2006. Science Competencies for Tomorrow's World, Vol. 1. A profile of student performance in reading and mathematics from PISA 2000 to PISA 2006* (Paris: OECD).
Pehkonen, E. (2008). *Problem solving in mathematics education in Finland.* In Proceedings of ICMI Symposium, 1-5.
Schmidt, W. H., Jorde, D., Cogan. L. S., Barrier, E., Gonzalo, I., Moser, U., Shimizu, K., Sawada, T., Valverde, G. A., McKnight, C., Prawat, R. S., Wiley, D. E., Raizen, S. A., Britton, E. D. & Wolfe, R. G. (1996). *Characterizing pedagogical flow. An investigation of Mathematics and Science teaching in six countries* (Dordrecht: Kluwer Academic Publishers).
Schmidt, W., Houang, R. & Cogan, L. (2002). A coherent Curriculum. The case of Mathematics. *American Educator*, summer 2002 issue, 1-17.
Vlaston, S. (2008). *Bilanţul evoluţiei educaţiei şi formării profesionale 1990-2008*, (http://edugate.ro/2008/07/13/comitetul-de-criza-pentru-salvarea-invatamantului-romanesc-publica-bilantul-evolutiei-educatiei-si-formarii-profesionale-1990-2008/).