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Reference levels in School Mathematics Education in Europe

National Presentation

GREECE

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1. General description of the school system (from the point of view of mathematics)

Mathematical education in Greece concerning the secondary school curriculum remained almost unchanged from 1985 to 1998. Since then, some essential changes have been made, especially for the last two high school classes, concerning the structure of the mathematical education.

Education in Greece has always been controlled by the central government via the Ministry of Education and Religious Affairs, with the consultation of the Pedagogical Institute.

Compulsory education has a duration of 9 years (ages 6 – 15), i.e. six years of primary education and three years in gymnasium. Differentiation starts at the age of 15, when the students can choose to continue for the next three years (ages 15 – 18) of secondary education either in Lyceum or in the technical education in the ``Technical-Professional Institutes``. The three classes of Lyceum are the main objet of this report.

1.1 History

The schoolbooks were exactly the same for everyone, in every grade, the Pedagogical Institute determined “what was taught” and “what was examined” and this procedure was completed by the School Advisors.

The main responsibility of the teachers was to teach everything that was indicated by the Pedagogical Institute and to prepare the students for the internal examinations of their school. This procedure applied to all grades. So, finishing high-school was an internal affair of each individual school.

Yet, in the third and last class of Lyceum, the students were divided in four different groups (called “bundles”) concerning a specialization for the national examinations to come, for entering the Universities. All groups consisted of four topics and corresponded to a number of specific departments of Universities or Technical Institutes.

| | Lessons | Universities |
|---------|-------------|-----------------------------------|
| Group A | Mathematics | Mathematical, Physical, Chemical, |

| | | |
|---------|--|--|
| | Physics Chemistry Composition | Biological, Geological departments, National Technical Universities, etc. |
| Group B | Biology Physics Chemistry Composition | Medical Sciences |
| Group C | Ancient Greek Language Latin History Composition | Philology, Archeology, History, Law Schools, etc. |
| Group D | Mathematics Econometrics (or Sociology in the early years) History Composition | Economical Studies, Management etc. |

After the completion of the internal school examinations for obtaining a high-school diploma, all third class Lyceum students could take part in the “National Examinations” for entering Universities. This system had two different stages, which were most important for the years to come.

At first (until 1989) every grade (from the first class of Lyceum) was working towards the selection of the students to enter University. The total grade of the A’ Class of Lyceum was multiplied by 5, the B’ Class grade by 7,5 and the C’ Class grade by 12,5, making a total mark over 500 (/500).

In the National Examination of the four topics of each Group, the total mark is calculated /1500. Thus, the selection of the students for the Universities was based upon their mark (/2000).

The advantages of this system, were that all the students were very concerned about their studies in all of Lyceum, in order to obtain good grades and that the selection for the Universities through the National examinations, was done after the student finished high-school. The main disadvantage was that the 25% of the total mark remained the responsibility of the individual school: there was no objective national control of the criteria.

The second stage of this system tried to improve this main disadvantage by creating a somewhat bigger one. Suddenly, in 1989, the total mark obtained in the three classes of Lyceum did not count in the total mark for entering the Universities. So, the students had only one obligation and objective: to simply pass their high-school examinations and then try to obtain good marks in four “independent” examinations.

Immediately, the topics in high-school began to faint and only the four topics for the National examinations were of some significance to the students, who were beginning the preparation for those topics separately from high-school, usually starting in the second class of high-school, neglecting all the other topics taught according to the secondary school curriculum.

Therefore, there was a need of radical change in the educational system.

1.2 The Educational Reform Act (1997)

The whole of the academic community agreed that a change in the educational system was necessary and should be radical. The one that took place is now under constant evaluation. The educational reform act that took place in 1997 concerns the whole educational system. We shall focus our attention on the changes in Lyceum, due to the subject of this report.

The topics taught in the first class of Lyceum remained almost the same and small changes have been made concerning the textbooks.

The examination system for the first class of Lyceum remained an internal responsibility of each school, becoming more objective, but also more difficult, since there was no longer a second chance in September for the students who failed to pass the examinations in June.

During the second class of Lyceum, things became more complicated. Students now had to choose between three “Orientations”, the “Scientific Orientation” (covering the exact sciences), the “Technological Orientation” and the “Theoretical Orientation”, each of which consisted of three extra lessons (and corresponding textbooks) added to this class curriculum.

The “Scientific Orientation” included Mathematics, Physics and Chemistry, the “Technological Orientation” included Mathematics, Physics and Communications Technology and the “Theoretical Orientation” included Ancient Greek Language, Latin and The Social and Principles of Philosophy.

The final written examinations are now taken at a National Level and in order to pass them, the student must gather a total mark of 9,5 or over, out of 20.

The total mark in each topic is mainly extracted by the final written examinations and the oral marks obtained from the classroom teacher can contribute to the total mark by a small percentage.

This mark has a value of 30% in the final mark of the high-school diploma, only if it is greater than the one obtained in the third class of Lyceum, which has a value of 70% (or 100% if it is greater than the one of the second class).

In the third class of Lyceum the “Orientations” remain the same – only the “Technological” is now divided in two cycles with a different theme. The “Scientific Orientation” includes the topics: Mathematics, Physics, Chemistry, Biology. The “Theoretical Orientation” includes the topics: Ancient Greek Language, Greek Literature, Latin, History. The “Technological Orientation – Cycle I” includes the topics: Mathematics, Physics, Mechanics, Chemistry – Biochemistry, Electrological Principles. The “Technological Direction – Cycle II” includes the topics: Mathematics, Physics, Creating Applications in Programming Environments, Principles of Economy and Management.

All other topics which are not included in the “Orientations” are considered topics of “General Education”.

There are also two topics of increased value for each “Orientation” which complete the final grade obtained by each student. Their contribution is 13% for the first and 7% for the second one.

In order to obtain the final mark with which the classification of the students for entering the Universities can be achieved, we have the following algorithm:

- The high-school diploma grade $\times 8$
- The grade of the first topic of increased value $\times 1.3$
- The grade of the second topic of increased value $\times 0.7$

resulting in a total mark (.../200).

From the point of view of Mathematics, there has been a reinforcement of their role in the secondary school curriculum.

In the first class of Lyceum the subjects of Mathematics to be taught remained almost the same (Algebra and Euclidean Geometry).

In the second class those subjects became a topic of “General Education” and one new textbook was added respectively for the students who will select the “Scientific” or the “Technological Orientation”. This textbook contains: Vectors, Analytical Geometry, Conic Sections and Number Theory.

In the third class of Lyceum there are “General Education” Mathematics containing Derivatives and Statistics and one textbook for the two “Orientations”. This textbook contains: Matrices, Linear Systems, Complex Numbers, Limits and Continuity of Functions, Derivatives of Functions and Integration.

There are also two courses in Mathematics which can be chosen by the students: one concerning Statistics (Advanced) and the other Mathematical Logic.

The above educational system is very ambitious and it is now under continuous evaluation. We also have to mention that mathematical education was also upgraded in the technical education offered by a new institution : the “Technical – Professional Institutes”, which took the place of the Technical Lyceums as an alternative way of education, after the completion of the compulsory 9-year education.

2. Main Mathematical Objectives (using Bashmakov Structure)

During the last few years, all national curricula concerning Mathematics contain detailed objectives concerning the teaching of each paragraph and also the abilities that are desired to be gained by the students.

This detailed analysis is included in the form of each analytical program proposed for every textbook in Mathematics.

The secondary school curriculum in Greece is very rich concerning variables and equations in Algebra, plane and analytical Geometry, and study of functions (incl. graphs).

There is a total absence of Geometry of the Space and very little on Data Analysis, since Statistics has just entered the national curriculum in the third class of Lyceum (there used to be only one chapter in the third class of Gymnasium).

A lot of work is being done with the students in “reasoning, deduction, proof”, especially with the teaching of Euclidean Geometry in the first two classes of Lyceum.

Yet, little work is being done concerning algorithms and visual thinking, abilities that must be systematically increased through proper pedagogical orientations.

The use of mathematical language is very poor at present, since there was a very strong effort, a few years ago, which “imposed” not to use mathematical symbols which can be described by words (i.e. $<$, $/$, $_$, $^$, etc.). Thus, the students have a great difficulty translating real-life problems to the mathematical world. Mathematical modeling has only just entered the school curriculum, but very strongly, due to the needs of the national examinations in Mathematics.

The lack of an organized structure in the application of Mathematics, related to the topics being taught, gives very little confidence to the students in using mathematics for solving real problems, yet the majority of students is very able in algebraic calculations and in the use of deductive learning, through investigation of conditions in problem solving.

Most of the students don't use self-control to establish the knowledge gained, even though they have been greatly encouraged to do so and they now have the proper material to use. The use of new technologies (computers) in the classroom is in a preparation stage. Only a minority of schools have computer laboratories and up to the present, educational CD-ROM's are being created or translated. Many pilot programs have been realised on this subject.

This overall picture can be additionally detailed as we proceed in the study of the application of the educational reform act.

3. Basic Contents

The revised version of the mathematics curriculum both in Primary and Secondary education covers the whole range of Mathematics to be taught.

For a broad overview of the basic contents of Mathematics in Lyceum we present the following table:

| A' Class of Lyceum | |
|--|--|
| Algebra | Euclidean Geometry |
| 1. Calculus in _ 2. Functions 3. Equations – Inequalities of 2 nd degree 4. Trigonometry | 1. Introduction to Euclidean Geometry 2. Basic Geometric Figures 3. Triangles 4. Parallel Lines 5. Quadrilaterals 6. Incircled Figures 7. Analogies 8. Similarity |
| B' Class of Lyceum | |
| GENERAL EDUCATION | |
| Algebra | Geometry |
| 1. Trigonometric Functions 2. Polynomials 3. Arithmetic and Geometric Progression 4. The exponential function– logarithms | 1. Metric Relations 2. Areas 3. Measurement of Circle 4. Lines and planes in space |
| ORIENTATIONS | |
| Scientific and Technological Orientation | |
| 1. Vectors 2. The line 3. Conic Sections 4. Number Theory | |
| C' Class of Lyceum | |
| GENERAL EDUCATION | ORIENTATIONS (Scientific and Technological) |
| 1. Elements of Differential Calculus 2. Elements of Statistics | 1. Matrices 2. Linear Systems 3. Complex Numbers 4. Functions: Limits and Continuity 5. Elements of Differential Calculus 6. Elements of Integral Calculus |

4. Exemplary Topics

4.1 Quadratic Equations

The students in Greece are quite familiar with the way of solving and handling quadratic equations. At first, the quadratic equations of the form $x^2=a$ ($a>0$) introduced in the second class of Gymnasium (age 13-14), following the Pythagorean Theorem and the square root.

In the third class of Gymnasium, these equations are both presented algebraically and through the study of the parabola in its simplest form $y=ax^2$.

In the first class of Lyceum, there is a profound study, which completes the presentation of the quadratic equation.

4.2 Pythagorean Theorem

Its presentation in the second class of Gymnasium (age 13-14) is basically used for the introduction of the square root. This attempt was not really successful, as the majority of students could not detect the great significance of the Pythagorean theorem and could not combine its use with the algebraic notions, which follow it.

The proper presentation of the Pythagorean theorem is done in the second class of Lyceum (age 16-17) (Metric Relations) according to the formal way.

We believe that a better (more geometric) approach of the Pythagorean theorem should be implemented throughout the Gymnasium courses, something that is not possible at present due to the complicated structure of the textbooks in these classes.

4.3 Similarity

Here, we find a problem similar to the §4.2. In the third class of Gymnasium (age 14-15), similarity is introduced through the chapter of trigonometry, losing most of its geometric interpretation. It may have been an interesting mathematical and pedagogical approach, but it ended with various results, since the students did not manage to obtain a clear picture of the meaning and (mostly geometric) applications of similarity.

The last topic to be taught in the course of Euclidean Geometry, in the A' class of Lyceum, is similarity, with a short but efficient presentation.

4.4 Word Problems

Word problems are not used or defined completely, so that they could be a part of teaching in the classroom. The majority of teachers include "word problems" in a general and not well-defined area of mathematical modeling, without essentially using either of them in the educational procedure. They only deal with word problems that are introduced by the textbooks or the national examinations.

Much effort has been made by many researchers of Math Didactics in order to persuade about the significant contribution of word problems to the immediate understanding of mathematical concepts, from the students.

4.5 Percentages

Percentages are introduced immediately in the A' class of Gymnasium (age 12-13), in continuation of problems taught in primary school.

This presentation is mostly practical and arithmetical, introducing only the notion of

percentages.

5. Other Topics

5.1 Regional Characteristics

The entire responsibility for education in Greece belongs to the Ministry of Education and Religious Affairs and the Pedagogical Institute. There are no variations of the educational system, regarding regional characteristics.

5.2 Implementation Strategies

The Pedagogical Institute has the full responsibility for the creation of the curriculum and the procedures involving the educational system. It is also responsible for any material to be taught in the classroom (textbooks, CD-ROMs, activities, etc.) and supports any action or problems that teachers may have, concerning the implementation of the curriculum.

A continuous effort is being made for improving the implementation strategies, through studies performed by committees including teachers of the secondary education, school advisors and academic university professors.

5.3 Resources available to teachers

Nowadays, many efforts have been made concerning the construction of a rich library in each school and the organization of conferences or congresses concerning secondary education.

There are also scientific journals with main subject mathematical didactics concerning the secondary school curriculum and also material provided for the evaluation of the students and of the educational process.

5.4 Problems already detected and improvements planned

There are a lot of weak points and problems concerning the new educational system that has been applied in our country.

There are already some large committees that are handling topics that concern the system's application and the Pedagogical Institute is trying to solve any ambiguous matters.

5.5 Data of general / local results

A lot of test data is being collected during the past two years, in order to detect the problems arising from the application of the system and to evaluate the contribution of students, teachers and educational material.

The evaluation of each individual school is also included in this program. Unfortunately, very little or inadequate information has been published or released to the press.

5.6 Examples of inspiring activities

There is a great effort, mainly from the Pedagogical Institute, to include as many activities as possible in the teaching process.

However, many problems prevent their use from the teachers. The main problem is the insufficient time schedule needed to support all these new subjects included in secondary education. It is the teachers' obligation and the students' demand to complete the test-centered material included in the textbooks and there is only a very restricted amount of time left to use for inspiring activities in the classroom.

It is the hope of the majority of mathematics teachers, that they will be able to exchange more lesson plans and create more activities, under the condition that enough time will be provided in the classroom to carry them out.

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