



EMS

**European Mathematical
Society**

<http://www.emis.de/>

**Committee on
Mathematics Education**

**Niveaux de référence pour l'enseignement des
mathématiques en Europe**

**Reference levels in School Mathematics
Education in Europe**

National Presentation

POLAND

Zbigniew. Semadeni

Mars 2000

1. General description of the school system

In September 1999 the Polish government officially introduced a major reform of the whole Polish educational system, changing the school structure, the concept of curriculum planning and syllabi, specific contents, suggested methods of instruction and the system of exams and evaluation. Information can be found at

<http://www.men.waw.pl/aktual/dok-ref/kszt-og/matemat.htm>

Thus, the previous system described briefly in this report is becoming extinct, whereas the future system is known only as a general outline. Constant monitoring and correcting the new system, particularly during the transition period of several years, is an inherent part of the philosophy of the reform. Consequently, this report will concentrate only on most important features of what was before and what is planned.

During the period of communist rule (from World War II to 1989), a basic rule was: a single unique syllabus for a given subject for each grade separately and one textbook (perhaps divided into parts, bound separately) for each subject and each grade (e.g., "mathematics for grade 6"). Around 1970, when a textbook on geometry, in the spirit of new math for upper secondary schools, turned out to be too difficult, authorities, for the first time, made an exception and agreed that another, more traditional, textbook should also be allowed and the teacher could make a choice. Later in the 1970's and 1980's such 'parallel' textbooks were accepted as an idea although they were still rare because of increased costs of printing and distribution. Moreover, until 1989 only one publishing house was allowed to publish school textbooks.

During the last ten years the situation has changed dramatically. There are now numerous competing companies which publish textbooks for schools. For a single grade one can find half a dozen or more textbooks on mathematics, of various didactical value. Each textbook, however, should obtain the approval of the Ministry of Education.

Until 1989 all schools were public and state-controlled. There were a few (less than ten) exceptions: some schools organized by the Roman Catholic orders (mostly vocational, but also some upper secondary schools, including one school of Sacre Coeur nuns). Such schools were harassed by authorities (particularly until 1956) and in danger of being closed at any time.

After 1989 there are three types of schools in Poland: public (which are now financed by local community; upper secondary - by county authorities), 'spoleczne' which are organized on non-profit basis by foundations or groups of teachers, and private. The costs of instruction in 'spoleczne' and private schools are partially subsidized by public funds and the rest is covered by the students' tuition fees and donations; generally, their classes are less numerous and teachers' salaries are higher than in public schools. All types of schools have to follow the guidelines of the Ministry of Education.

In the previous school system there was a basic school ('szkola podstawowa") comprised of grades 1-8, divided into grades 1-3 and 4-8.

On average, Polish children are between 6;8 and 7;8 when they start school in grade 1. This is usually preceded by one year in kindergarten (or in grade 0 organized by the school).

In grades 1-3, in principle, a single teacher teaches all subjects; from grade 4 on, the class is taught by several teachers, including one responsible for mathematics.

After grade 8 of the basic school, about one third of students (specifically, 35%, with growing tendency) attended university-leading 'liceum' for four years (grades 1-4 or 9-12), which ended with a state-controlled exam, called 'matura', one third (33%) attended various kinds of upper secondary semivocational schools which, similar to liceum, ended with matura, and the other third (29%, on the decline) continued learning in vocational schools,

In the new system which is now being introduced there are: basic school (grades 1-3 and 4-6) followed by 'gimnazjum' (grades 1-3, that is, 7-9). Gimnazjum is compulsory for all and (at least theoretically) no such school should be just for select children. Thus, the 8-year single type of basic school is replaced by the 6+3 system. The unified system of schooling is extended from 8 years to 9 years.

[Pronunciation: guim-naz-ume; li-tse-um with Latin/German 'um'; stress in the middle - Z.S.]

In the new system, in grades 4-6 and in gimnazjum, there are about 4 lessons of mathematics per week. On average it means about 70% of time allocated for mathematics in 1975; almost every curriculum reform in the last quarter of century resulted in some reduction of the number of mathematics lessons.

The Ministry declared that in grades 1-3 of basic school the instruction must be 'integrated', without fixed allocation of time to separate subjects: Polish (reading, writing), arithmetic, arts etc. Many people are afraid that this may result in an actual cut of time devoted to mathematical activities, particularly in those classes where the teacher does not like this subject. At the same time the Ministry reduced the number of standard teaching hours by 3 hours per week in each of grades 1-3; the principal has to decide for what kind of activities these 3 hours will be used (perhaps for computers, or a foreign language, or remedial lessons). In practice it will likely mean a further reduction of mathematics learning.

Previously, the typical age of finishing the compulsory education was 15 (if the student had not dropped out and had not repeated any grade); from the year 2001 on, the typical age of ending the unified system of education will be 16.

By law, the education is now compulsory till the age of 18. After gimnazjum, students will have some options: liceum (grades 1-3) or some vocational education. Thus, the university-leading path

changed from previously 8+4 to 6+3+3 (or 3+3+3+3 if grades 1-3 of basic school are counted separately).

There are several kinds of liceum (the most popular is 'general', but there may also be economical liceum, or technical, or medical). In a general liceum, there may be classes with different curricula: mathematico-physical type (usually having the best students and where the syllabus includes differential calculus and a bit of integral calculus), humanistic (often including those students who are just poor in mathematics and where no calculus is taught), biológico-chemical, and 'standard' (without emphasis on any particular group of subjects and where introductory calculus is taught. Standard type is preferred by those schools which have not enough students of a given age to organize several parallel classes).

The Ministry has recently announced a controversial decision that a written exam in mathematics will be a compulsory subject at the future matura exams. The students will have options: the 'basic level' or the 'advanced level'.

The philosophy of the curriculum changed as follows: instead of syllabus for each subject and each grade, the Ministry of Education has published a document called 'podstawy programowe' ('syllabus base'). There may be several specific sets of syllabi, worked out by various authors or teams of authors. Each such syllabus must be consistent with 'podstawy'; in particular, it must contain all topics listed in 'podstawy', but may differ in the way general ideas are made specific and may also include supplementary material.

If a syllabus is worked out by a single teacher, or a group of teachers, from one school and is used only in this school, it has to be accepted by the principal; otherwise, it has to get an approval of the Ministry of Education and then it can be used (or adapted) in any school in Poland. Each syllabus concerning mathematics must specify the material for each of 3 successive grades (i.e., for grades 4-6 of basic school or for the whole gimnazjum). Such a syllabus is often sponsored by a publishing company and is accompanied by a series of textbooks.

The Ministry of Education has announced that they work on a system of standards and on a system of exams. Instead of the present situation where all the marking and evaluation is in the hands of the teacher (except of 'matura', the final exam at the end of upper secondary education), there should be external systems of evaluation after grade~6 and after gimnazjum, directed by agendas of the Ministry. Details are not yet known, but the influence of the system introduced in England some years ago is noticeable.

Another major change is the moment and the place of exams. Until now, those who finished grade 8 have had to pass an entrance examination to the liceum; it was organized soon after the end of the school year by each liceum separately. There were also entrance examinations to universities (organized by the faculty at the beginning of July, some weeks after matura exams). In the future system, at the end of gimnazjum, students will take final exams at their schools and the results will serve to select candidates to the liceum. Similarly, the Ministry insists that marks on 'matura' should replace the entrance examinations as a way of selecting people to universities. In particular, the results of the matura exams in mathematics (at the advanced level) should serve as a unique criterion for graduates to be admitted to university studies with mathematics or computer science as the major subject.

The problem of selection is particularly acute at those licea and those divisions of university studies which have many more candidates than vacancies for students (sometimes 10 times more

candidates than the upper bound of the number of new students admitted). It is not unusual that universities do not trust the marks from matura and prefer the burden of entrance exams; an argument is that those who will have to teach the student for several years are more interested in the objectivity of results.

2. Main mathematics objectives

According to 'Podstawy' for grades 4-6 and for the new Polish gimnazjum (age 13-16), the goals of mathematics education are: Developing students' understanding of basic concepts of arithmetic and geometry; preparing students to use mathematical knowledge to solve problems arising in various school subjects and in daily life and to construct mathematical models for concrete situations; learning the language of mathematics; identifying, formulating, solving and discussing problems; developing students' spatial intuitions; fostering students' abilities to think logically and to formulate clear answers.

Polish teachers have the tendency to concentrate on the contents of the syllabus; consequently, the official goals, formulated in very general terms, have little influence on the practice of instruction.

3. Basic contents

The following topics are listed in 'podstawy' for grades 1-3 of gimnazjum (i.e., for grades 7-9):

- Rational numbers, operations on them and comparing such numbers; examples of using pocket calculators; percentages with practical applications; powers with integer exponents, properties of exponentiation; roots and their basic properties.
- Decimal approximations of real numbers; examples of irrational numbers.
- Writing algebraic expressions and computing their numerical values; formulas for the squares of $a+b$ and $a-b$ and for the product $(a+b)(a-b)$.
- Examples of functions (including non-numerical and non-linear functions); reading properties of functions from their graphs.
- Linear equations with one unknown, linear inequalities with one unknown; systems of two linear equations with two unknowns and their geometric interpretation.
- Collecting, sorting and presenting data (with the use of technology if possible).
- Simple random experiments.
- Polygons, circles and disks; perpendicular bisector of a segment and bisectrix of an angle; angles inscribed and central angles in a circle; criteria for congruence of triangles; the circle inscribed in a triangle, the circle circumscribed round a triangle.
- Examples of geometric transformations.
- Perimeter and area of a polygon; the area of a disk and the circumference of a circle.
- Relations between dimensions of sides etc. of figures; the sum of the angles of a triangle; Pythagorean theorem and its applications; similar figures.

- Perpendicularity and parallelism in 3D space; right prisms, pyramids and surfaces of revolution (cylinder, cone, ball [that is, a 3D solid: a sphere together with its interior]). (Nowadays, balls and spheres are carefully distinguished in Polish schools, as are disks and circles, Z.S.).

It is expected that students will be able:

- to perform noncomplicated mathematical reasoning,
- to use properties of numbers and arithmetical operations and properties of figures to solve problems,
- to use pocket calculators in appropriate situations,
- to notice, make use of and interpret functional relations; interpret relations expressed with formulas, graphs, various schemes, diagrams, tables,
- to present, using mathematical language, results of exploring simple questions.

4. Exemplary topics

4.1. Quadratic equations.

The quadratic equation (with all three terms) is traditionally a topic for liceum (now in grade 10). It is generally preceded by a study of quadratic functions and parabolas as their graphs. The general case is solved by completing the square; students learn the formula for the solutions of quadratic equations and the role of the sign of the discriminant, delta.

4.2. Pythagorean theorem

This is a standard topic for the level of gimnazjum. The theorem is always presented as $a^2+b^2=c^2$ and is interpreted as a relation between the lengths of sides of a right triangle; it serves as a way of computing the hypotenuse or a leg (as a square root). Interpretation in terms of areas of respective squares is often given, but plays a secondary role. Some teachers show a proof (based on proportions or on cutting figures).

4.3. Similarity

Scales (in the context of maps) are already present in grades 4-6. More systematic study of similar figures and proportions is a standard topic at the gimnazjum level. Teachers' tradition includes Thales theorem (in Poland it means the theorem on proportions in the case of two parallel lines and an angle).

In liceum (especially in the mathematico-physical type) similarity is regarded as a geometric transformation.

4.4. Word problems

In Polish educational tradition, word problems have always been the most popular form of problem solving since grade 1 of primary school (if children cannot read yet, the teacher reads the problem,

often illustrated with a picture). As in any country, word problems always are regarded as difficult. They are supposed to develop students' ability to apply mathematics and skills of modelling, but many problems printed in textbooks are based on formal mathematics disguised as text rather than genuine practical problems.

Equations are often used to solve (or sometimes to interpret) a word problem. Depending on the textbook author, equations may occasionally appear, even in grades 1-3 or in grades 4-6 of basic school. Above this level, equations are regarded as a standard tool for solving word problems.

4.5. Percentages

Easy cases of percentages appear in grade 6, introduced as some kind of decimal fractions. Computation of bank interest is a typical exercise. Percentage is used later for interpreting statistical data etc. Students have serious difficulties with inverse problems and with problems where several quantities appear.

4.5. Functions (an additional example).

Since the 1970's the concept of a function has played an important role in the Polish mathematics curriculum. In secondary education teachers demand that students determine the domain of each function considered by them. The traditional notation of type $y=f(x)$ is used together with other symbols, particularly various arrows. Some authors stress the importance of showing a broad sense of the concept, not only real-valued functions of real variable, but also examples of functions on sets of arbitrary objects (not necessarily mathematical). Also the language of functions is recommended when interpreting various data.

5. Other things

5.1. Regional characteristics

There are no conspicuous differences between various parts of the country, except those which follow from economic differences. There may be drastic differences between education in certain rural areas and cities like Warsaw, particularly in upper secondary education.

During the present reform, numerous small schools are being closed; in several places this has caused very strong protests from the local communities. In thousands of villages the previous basic 8-year schools are being changed into 6-year schools, with gimnazjum in another village or town. Inhabitants regard this as making education more difficult for their children; the Ministry of Education argues that strong, big schools and bussing children is a better solution.

5.2. Implementation strategies

The Ministry of Education has organized a 'cascade' system of preparing teachers for the present reform: first of all there are courses for groups of leaders, who then organize courses for those who meet the teachers. However, most of the energy is used for explaining the ideas of the reform and

to convince teachers of their pedagogical value rather than for genuine teaching problems. 5.3. Teacher training

For over a quarter of a century, the standard way of preservice preparation of mathematics teachers was 5-year university education at the mathematics department of a university or Wyzsza Szkola Pedagogiczna (WSP; this can be literally translated into German as 'Paedagogische Hochschule'; in English it may be described as 'Pedagogical University', as such a school offers master programs and some of them can grant Ph.D.s in mathematics). Graduates of this system could teach mathematics in basic schools from grade 4 on, and in secondary schools.

For a prospective teacher, credits for courses in pedagogy, psychology and didactics of mathematics are obligatory.

During the recent years, the Ministry of Education has worked out a program of 3-year preservice training of mathematics teachers for basic schools; the graduates get the title 'licencjat'. They can now also teach in the gimnazjum (but not in liceum). Such a program may be offered by a university or a WSP; then a graduate of it can continue for two more years to get a masters degree. Such programs are also offered by separate schools ('kolegia') which, however, do not have the right to offer masters programs.

In Poland, numerous postsecondary schools (for teacher training, for business etc.) have been organized in recent years; many of them are private.

5.4. Resources available to teachers

In each district of Poland there is a centre for helping teachers (e.g., by organizing short-term in-service courses). There are over 50 such centers. Many of them are now reorganized. The reasons are: the reform of education and a simultaneous major reform of the system of Polish administration.

5.5. Problems and improvements already detected

One of the problems for many years in Poland has been a shortage of mathematics teachers and, simultaneously, the difficulty with finding a position in a school by new graduates. The reasons are numerous. One of them is a drastic decrease in the number of children from rural areas and small towns that continue education at postsecondary level; prospective teachers born in university cities have little motivation to look for poorly paid teacher's positions elsewhere; this is combined with drastic shortage of apartments to rent. Secondly, because of very low salaries, principals often let their teachers have extra lessons (over the official teaching load), separately paid, and therefore they are reluctant to admit they have vacant positions in the school. Thirdly, mathematics lessons are often taught by people who have some education other subject areas; say, in biology.

5.6. Data on general/local results

In 1984 the Polish government sponsored a nation-wide survey of achievements of students of grade 4, of grade 8, and of the terminal grade of liceum (i.e., grade 12). This included mathematics. The results, which have not been published and are available only in a mimeographed form, showed that the results were as they had been expected: the difference between the intended

national curriculum and the actual knowledge of students was dramatic. Only a fraction of students achieved the officially intended goals.

As a by-product of that survey, an alarming report on the scale of private, out-of-school tutoring in mathematics (paid by parents or provided free by relatives or friends) has been published (in *Wiadomosci Matematyczne* vol. 29, 1990, pp. 123-129).

Soon after 1989 the compulsory material in syllabi was reduced. It is not clear to what extent the present situation is similar to that of fifteen years ago. Valid data will be expected when the new system of external examinations is introduced.

References

Ministerstwo Edukacji Narodowej, *Reforma systemu edukacji (projekt)*, Wydawnictwa Szkolne i Pedagogiczne, Warszawa 1998.