Polish educational system

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The text of this analyse has been accomplished by the end of May 2017 and its content refers to the information, laws and general knowledge available at this moment.

Authors

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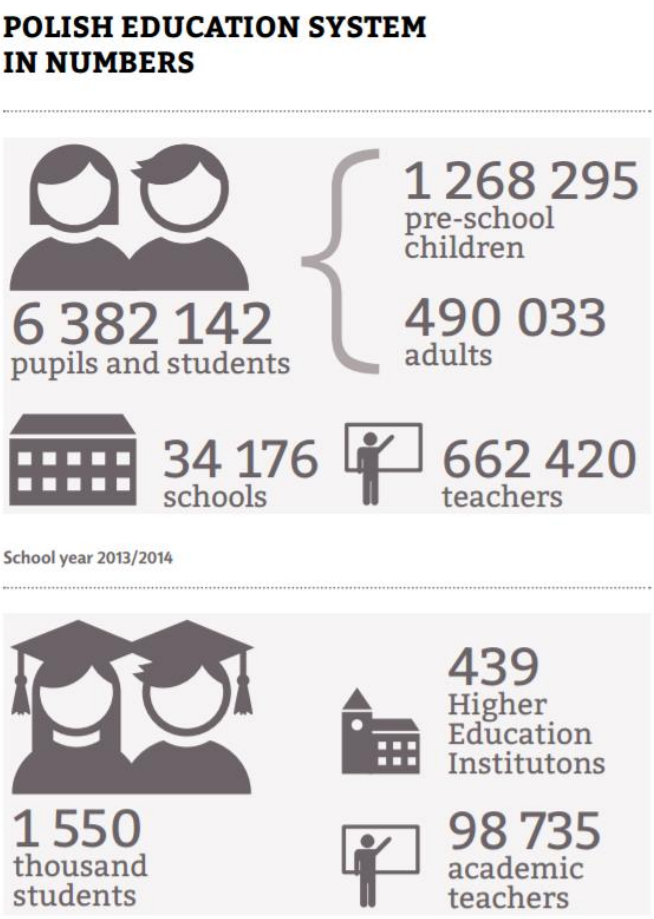
Overview

The main legal basis for education in Poland is provided by the Constitution of the Republic of Poland. According to its provisions:

- every person has the right to education,
- education is compulsory until the age of 18,
- education in public (state) schools is free of charge,
- parents are free to choose schools other than public schools for their children,
- public authorities provide citizens general and equal access to education.[1]



GRAPHICS 1 POLISH EDUCATION IN NUMBERS *

The education system in Poland is centrally managed by two institutions – the Ministry of National Education (general and vocational education) and the Ministry of Science and Higher Education. The national educational policy is developed and carried out centrally while the administration of education and the running of schools are decentralized.

In Poland about 54% of children are going to nurseries. Preschool is obligatory for 6 year olds. Compulsory education lasts till the 18th year of age (full-time or part-time, vocational or non-tertiary). In 2013-2015 there were attempts to make schooling compulsory from the 6th year of age. After many protests and the change of government it is due to the parents decision if the child starts school education as 6 (with a positive opinion of a psychologist) or 7 years old (compulsory).[2]

* The sources of graphics, figures and tables are given in an index at the end of this document.

The history of reforms in Polish educational system after WWII (the main facts).

1945 – 1961 – the schooling organization is reconstructed as it was before the War, but the content of education is dominated by communistic ideology.

1961 – a new organization of education is implemented (with 8-years of primary and 4 years of secondary education)

1989 – after the political transformation the organization of schooling remains the same but the content is free of the communistic ideology

1999 – the organization of education is changed with: 6-years primary, 3-years of lower-secondary and 3 years of upper-secondary schools. Education is decentralised, running of schools is in gesture of local authorities while educational policy is managed centrally.

2008 – with the organization remaining the same there are significant changes in the aims and methods of education (new core curricula)

2017 – the reform of education is announced to be implemented from September. 8-years primary and 4-years secondary schools are introduced; the core curriculum and the content of education is being changed.

In 2016 the Polish government announced changes in educational system[3] and they are to be implemented starting from September 2017. The situation is still dynamic and changes are still expected. The main change cancels the middle level of school education - lower secondary schools. Primary education is prolonged while secondary education has only one level (without the division into "lower" and "upper"). The child's compulsory schooling is finished when it is 15 or when it finishes the primary school. Table 1 *Polish Educational System* compares the present and the new system. [4]

Polish Educational System[5]

The Polish educational system consists of the main types of schools

- przedszkole – nursery,
- szkoła podstawowa – primary school,
- gimnazjum – lower-secondary school,
- liceum – general upper secondary school,
- technikum – technical upper-secondary schools,
- szkoła zawodowa/branżowa – basic vocational upper-secondary school.

Compulsory education covers full-time school education (up to the age of 16) and part-time education (up to the age of 18). Full-time compulsory education is divided into:

a) one-year pre-school preparation;

b) full-time education in school that lasts until the completion of lower-secondary school but not beyond the age of 16.

Part-time compulsory education concerns students aged 16–18 and may be organized:

a) in upper-secondary schools, both general and vocational;
b) at the employers' premises (apprenticeship system).

The table below gives general overview about schooling according to the children age before and after the 2017' reform.

<table>
<tr><th>AGE OF CHILDREN</th><th>SCHOOL SYSTEM DURING 1999-2017</th><th>SCHOOL SYSTEM STARTING 1ST SEPTEMBER 2017</th><th>COMMENTS</th></tr>
<tr><td>3-6</td><td>Nursery</td><td>Nursery</td><td>Only the last year is compulsory (pre-school)</td></tr>
<tr><td>7</td><td rowspan="3">Primary school – 1st stage: integrated early school education</td><td rowspan="3">1st stage of primary school: integrated early school education</td><td rowspan="6">Compulsory</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td><td rowspan="3">Primary school – 2nd stage - subject-based teaching</td><td rowspan="4">2nd stage of primary education: subject-based teaching</td></tr>
<tr><td>11</td></tr>
<tr><td>12</td></tr>
<tr><td>13</td><td rowspan="3">Lower-secondary school – (general) subject based teaching</td></tr>
<tr><td>14</td></tr>
<tr><td>15</td><td rowspan="4">Upper-secondary school (general, technical, non-tertiary or vocational education)</td><td rowspan="4">Compulsory full-time or part-time education till the age of 18.</td></tr>
<tr><td>16</td><td rowspan="3">Upper- secondary school (general, technical, vocational or non-tertiary education)</td></tr>
<tr><td>17</td></tr>
<tr><td>18</td></tr>
<tr><td>Adults</td><td colspan="3">Autonomous higher education institutions (first-, second- and third-cycle programmes, long-cycle Master's degree programmes are available only in a few fields of study). Public and non-public schools are available for adults in:
public and private higher education institutions,
continuing education centres,
practical training centres,
in-service training centres,
general upper-secondary school for adults.</td></tr>
</table>

TABLE 1: POLISH EDUCATIONAL SYSTEMS BEFORE AND AFTER SEPTEMBER 2017

The aims for school education

The Ministry of Education announced in February 2017 the new core curriculum of primary education [6]. Most of objectives which were developed in lower-secondary schools are transferred to the 2nd stage of primary schools while the upper-secondary schools are being transformed from 3 years to 4 years courses (5 years for vocational schools).

Primary education

From September 2017 compulsory general primary education will be divided into three stages:

- Stage 0 – one year pre-school (provided by a school or by a nursery),
- Stage 1 – including grades 1 to 3 of the primary school and covering early school education,
- Stage 2 – including grades 4 to 8 of the primary school. (grades 4-6 before 2017).

Main skills to be acquired in primary education are: reading, writing, mathematical thinking, scientific thinking, communication skills in the mother tongue and in a foreign language, the ability to use ICT effectively, learning to learn, teamwork skills. According to the report "Polish educational System" Prepared by the Polish EURYDICE Unit in consultation with experts from the Ministry of National Education and the Ministry of Science and Higher Education:

- general education in the primary school aims to enable pupils to:

1) *acquire a basic body of knowledge about facts, rules, theories and practice related in particular to topics and phenomena close to their experience;*
2) *acquire the ability to use the knowledge gained to carry out tasks and solve problems;*
3) *develop attitudes which are necessary for efficient and responsible functioning in the modern world;*

- the most important skills to be acquired by pupils in primary schools include:

1) *reading: understood as both a simple activity and the ability to understand, use and process texts to an extent enabling acquisition of knowledge, emotional, intellectual and moral development, as well as participation in social life;*
2) *mathematical thinking: the ability to use basic mathematical tools in everyday life and to apply elementary mathematical reasoning;*
3) *scientific thinking: the ability to formulate conclusions based on empirical observation related to nature and society;*
4) *communication skills in the mother tongue and in a foreign language, including both speaking and writing skills;*
5) *the ability to use ICT effectively, including the ability to search for and make use of information;*
6) *learning to learn as a means enabling pupils to satisfy their curiosity about the world, to identify their interests and to prepare for further education;*
7) *teamwork skills.*

The structure of secondary education

Upper-secondary schools are still following the former core curricula (from before the 2017 reform) and new ones are not announced yet (May 2017). However, it is known that at this stage of education after graduating from lower secondary schools in the present system or graduating from primary school in the new system - the students are choosing the type of their future education:

They are:

A. 3-year **general upper-secondary schools** or 4 year secondary schools after 2019 (starting 1st September 2019),
B. 4-year **technical upper-secondary schools** or 5 year **technical secondary schools after 2019,**
C. 3-year (4-year after 2019) **basic vocational schools,**
D. **non-tertiary education.**

General upper-secondary schools offer full-time general education. At the end students take the matriculation examination that leads to the receipt of the matriculation certificate required for admission to higher education. The main objective of general upper-secondary education is to prepare young people for admission to higher education establishments of various types.

In general education students follow compulsory subjects on a basic level and chosen subjects on an extended level. They may choose no less than 2 and no more than 4 subjects at the extended level.

The forthcoming reform of education ‘2017

The main objective of the reform is to provide better education in the upper secondary schools. It was noticed that 3-grade course is too short , and the upper-secondary school was mainly the training for the final exam. The learning process was superficial. As the result Polish students were not prepared well to the high education and universities reclaimed that the candidates’ level is getting lower each year.

In 2016 the Ministry of National Education decided to restore the structure of educational system in its shape from the period 1961-1999: 8 years of primary and 4 years of secondary school. Consequently lower secondary schools are being cancelled (as presented in the first chapter of this analysis). Significant changes to the curricula are implemented as well.

During past 16 years Polish schools developed a number of successes and achievements getting a lot of experience as well as the trained and highly qualified staff. It is essential now to keep the benefits of the present educational system and transpose them to the new one. These benefits are:

- highly specialized staff of lower-secondary schools,
- project-based teaching,
- high scores of Polish lower-secondary school students in PISA tests:
    - 4th score in UE in reading,
    - 6th score in UE in mathematics,
    - 10th score in UE in science,

- infrastructure adapted to the needs of lower-secondary education.

Polish teachers see a lot of difficulties ahead. The process of changes is very fast. The subject is very hot and widely discussed.

Curricula and textbooks

It is due to a teacher (or the counsel of the school's teachers) to choose the curriculum and as well as the textbook to be bought for the pupils by the school.

GRAPHICS 2 THE SCHOOL AFTER CHANGES - MATERIALS OF MINISTRY OF NATIONAL EDUCATION

The Ministry of National Education announces the core curriculum which is the obligatory basis of education. Educational publishing houses are free to choose authors of textbooks and curricula for schools. The issued materials have to be certified by the Ministry of National Education experts in order to be approved to use. The teachers may write they own curricula and materials and use them with the approval of Regional Education Superintendent.

The Core Curriculum defines the learning outcomes and some general requirements for the organisation of teaching. Core curricula have to be respected by each school, but school curricula are chosen at the school level.

Due to these regulations the educational publishing houses are playing the crucial role in the process of creating curricula and textbooks and the rules of free market decide of the success of a publication. The publishing houses are obliged to:

- respect the core curriculum and the teaching schedule announced by the Ministry of National Education,
- respect the regulations[7] and requirements referring to the compositions, content, quality international standards,
- for the textbook: achieve a positive opinion and acceptation of two or more experts from the Ministry of National Education.

Every curriculum describes the obligatory elements: main aims (educational, social), teaching schedule (with the number of hours needed for every topic), plan of results, methods of evaluation. The curricula are constructed in such a way that the number of hours estimated for

content, task solving, repetition, evaluation and discussion are within the framework teaching schedule.

The curricula and textbooks have to be closely related and are offered by various publishers. They differ mainly in composition, order of topics, difficulty of tasks, and in the extra content provided.

Teachers choose textbooks from the list approved by the Minister of National Education. It is due to the teacher and the headmaster of the school which textbook and curriculum they chose. The choice on the textbook is very wide. Publishing houses follow various points of view. There are two main trends in the textbooks:

- The textbook concentrates on the core curriculum and does not go behind it. They provide only the very basic knowledge so they are chosen by the teachers working with students with lower abilities or ambitions. The basic curriculum is well trained and the students are not overwhelmed by the amount of difficulties.

- The textbook extends the core curriculum and provides much more knowledge then the basis. These textbooks and curriculums are chosen by ambitious teachers for use with classes of high abilities and extended education of physics.

Teachers' individual curricula

In many cases the teacher decides to create her/his own curriculum and in most cases it is a very individual way of teaching. Yet a lot of innovative curricula are written and implemented by individual teachers, still they are not published, shared or implemented outside of the authors' schools because they are not required to be. In Mazovia province there were 4728 innovative curricula in 2016/2017 (total for all subjects and school types) [8]. The individual curriculums – called *educational innovations* – have to fulfil formal conditions and be approved by the headmaster and pedagogical staff of the school, and consequently by the Regional Education Superintendent. All curricula have to be based on core curriculum approved by Polish Ministry of National Education. In the curriculum documentation the author has to include: the content, the methods used, the facilities needed, the schedule of implementation. The *innovations* may require extra hours of teaching and the school may be given funding for that by the govern body. It is not required to publish, share or release the individual curriculum documentation. In most cases it remains known and used only by the author and is considered to be the individual way of teaching, consisting the teacher's best practices and adapted to the school's needs.

School subjects in general education

Table 2 defines the number of school subjects in general education. However, artistic schools, special education, ethnic minorities and sports schools have their own regulations where the number of teaching hours is adjusted to the needs of specific kind of education.[9]

1st stage: early education (grades 1-3)	20 teaching hours**/week integrated education (Polish language, mathematics, musical and art education, ICT, PE, natural science, foreign language)
	Extra subjects: 2 teaching hours a week (optional)
	Religion/ethics 2 teaching hours a week (optional)

TABLE 2 TEACHING HOURS IN THE EARLY EDUCATION

**1 teaching hour is 45 minutes.

2nd Stage (grades 4-8)	number of teaching hours** a week				
	4th grade	5th grade	6th grade	7th grade	8th grade
Polish language	5	5	5	5	5
Foreign language (*In CLIL classes)	3	3	3	3 (+2)*	3 (+2)*
Second foreign language				2	2
Music	1	1	1	1	
Art	1	1	1	1	
History	1	2	2	2	2
Knowledge About Society				2	
Natural Science	2				
Geography		1	1	2	1
Biology		1	1	2	1
Chemistry				2	2
Physics				2	2
Mathematics	4	4	4	4	4
Information Technology	1	1	1	1	1
Technics	1	1	1		
Physical Education	4	4	4	4	4
Safety Education					1
Lessons With Class Tutor	1	1	1	1	1
Career Counselling				min. 10 hours a year	min. 10 hours a year
Extra subjects (Optional)	3				
Religion/Ethics (Optional)	2	2	2	2	2

TABLE 3 SUBJECTS' HOURS PER WEEK IN PRIMARY SCHOOL (STARTING SEPTEMBER 1ST, 2017)

Table 4 (below) shows the number of classes according to the newest plans (May 2017). However, this is only a project of regulations, not an official statement of the Ministry of National Education.

Stage 3: upper-secondary school (general education)	Number of teaching hours** a week			
Compulsory subjects, basic level	1st grade	2nd grade	3rd grade	4th grade
Polish language	4	4	4	4
Foreign language (*in CLIL classes)	3+3*	3+3*	3+3*	3+3*
Second foreign language	2	2	2	2
Music, art or philosophy	1			
Knowledge about society	1	1		
Introduction to entrepreneurship	1	1		
Geography	1	1	1	1
Biology	1	1	1	1
Chemistry	1	1	1	1
Physics	1	1	1	1
Mathematics	3	4	3	4
Information technology	1	1	1	
PE	3	3	3	3
Safety education	2			
Lessons with the class tutor	1	1	1	1
Career consulting	minimum 10 hours during the 4 years			
Subjects at extended level	3	4	7	6
Extra subjects (optional)	2			
Religion/ethics (optional)	2	2	2	2

TABLE 4 SUBJECTS' HOURS PER WEEK IN SECONDARY SCHOOL (GENERAL EDUCATION)

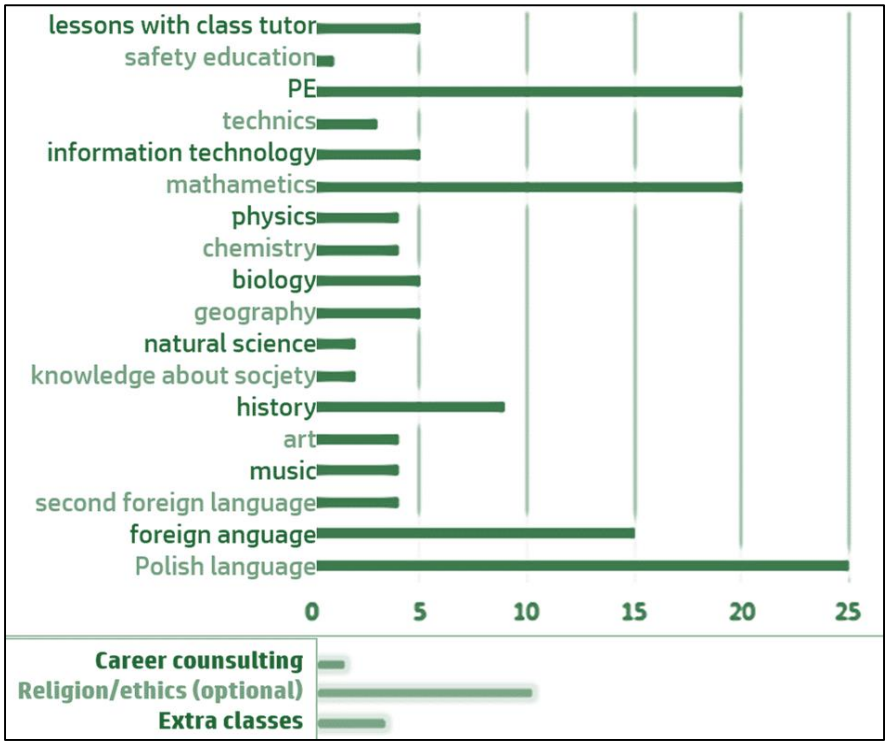


FIGURE 1 COMPULSORY SUBJECTS IN THE 2ND STAGE OF PRIMARY EDUCATION

Figure 2 COMPULSORY SUBJECTS IN THE GENERAL SECONDARY PRIMARY EDUCATION

In upper secondary education pupils choose the subjects they want to extend. They can chose one or two subjects. Subjects which can be taught at the extended level are: Polish language, history, geography, biology, chemistry, physics, history of music, history of art, Latin, ancient culture, and philosophy, a modern foreign language, knowledge about society, mathematics and IT.

The headmaster may provide the pupils some extra subjects, but the number is limited as showed in Tables 3 and 5. Extra classes are given to the teachers for implementing innovations or dividing the classes into smaller groups.

As the Education Reform is still “under construction” many changes are still expected. The new system will be implemented from 2019 to upper secondary schools. The reasons and predicted consequences of the reform are described in one of the next chapters.

Formal and informal education

Polish educational system is supplemented by informal education in many ways. Informal education is provided at schools and by numerous external institutions of various kinds.

Firstly, informal education is provided also at schools. Besides regular classes and curricular activities every school provides extra classes. On extra classes the pupils work with the same teacher, but the classes are not compulsory and the curriculum is not defined strictly. In most

cases these kind of classes is connected with the teacher's passion or specialization. The students are also assisted by the teacher when preparing to a competition.

Moreover, there are numerous off-school public educational institutions. Local and regional educational and cultural institutions, called Community Centres financed by the proper authorities, are a very important supplement to the educational system. They often cooperate with schools in providing education, organizing events and supporting students of every age. The Centres offer a big amount of activities. Among these a huge number is connected with STEM: workshops, robotics, observatories, laboratories. The educators are recruited as well from teachers as from other professions; many hobbyists are employed as well as scientists and engineers.

Furthermore, local science centres, cultural institutions and museums provide informal education on the local level. A big number of new institutions were founded in last 10 years and are developing dynamically. They provide regular lectures, workshops, activities, in many cases based on the local heritage.

High education and science institutions also provide informal education. Educational boom of the 90s caused the development of high education and science institutions. The schoolchildren are readily frequenting educational services offered by universities and academies. The services are regular or occasional, there are numerous events and festivals too.

Commercial institutions have their share in informal education, providing all kinds of trainings and course. Private lessons are still a common practice in Poland, and especially with physics and mathematics they have a far-reaching impact for educational results.

Science and physics in education

The table below shows the subjects where physics is included (STEM) in the curriculum according to the former and the new educational system.

AGE OF CHILDREN	1999 - 2017	STEM IN EDUCATION (TOTAL NUMBER OF TEACHING HOURS)	STARTING 1ST SEPTEMBER 2017	STEM IN EDUCATION (TOTAL NUMBER OF TEACHING HOURS)
7	1st stage of primary school: integrated early school education	As a part of integrated education	1st stage of primary school: integrated early school education	As a part of integrated education
8				
9				
10	2nd stage of primary	Natural science as a subject:	2nd stage of primary	Natural science 60 geography 160

<table>
<tr><td>11</td><td rowspan="2">Education: subject-based teaching</td><td rowspan="2">290 hours</td><td rowspan="3">Education: subject-based teaching</td><td rowspan="3">Physics 130
Chemistry 130
Biology 130</td></tr>
<tr><td>12</td></tr>
<tr><td>13</td><td rowspan="3">Lower-secondary school</td><td rowspan="3">Geography 130
Physics 130
Chemistry 130
Biology 130</td></tr>
<tr><td>14</td><td rowspan="2">Secondary school (general, technical)</td><td rowspan="2">Geography 130
Physics 130
Chemistry 130
Biology 130

Subjects taught at the extended level
+600 hours in total</td></tr>
<tr><td>15</td></tr>
<tr><td>16</td><td rowspan="3">Upper-secondary school (general, technical or vocational)</td><td rowspan="3">Geography 30
Physics 30
Chemistry 30
Biology 30
Subjects taught at the extended level
+870 hours in total</td></tr>
<tr><td>17</td></tr>
<tr><td>18</td></tr>
</table>

TABLE 5 STEM IN THE CORE CURRICULUM ACCORDING TO THE PRESENT AND THE NEW EDUCATIONAL SYSTEM

Development of scientific, social and cross-curricular skills

Teaching patterns in STEM

Effective teaching process requires activity both from the teacher and from the students. In this relationship the most important factor is the model of teaching and learning chosen by the teacher (or school) and its adequateness for students' needs. There are 6 main teaching patterns in Polish schools:[10]

1. lecture - passive transfer of knowledge,
2. conceptual - emphasizing logical thinking,
3. demonstrating - showing experiments and examples,
4. collaboration - training soft skills (interpersonal, communication, social),
5. inquiry - engaging creativity and problem solving,
6. direct - process-based, with high level of students' activity.

These patterns are used and chosen by teachers according to their personal skills and preferences, usually a teacher uses all of them in various proportions. In the 20th century, till 90s, the first 3 patterns were the most popular. From that time a lot has changed. The main factors were: political transformation and the education reform following, joining EU and implementing Europeans standards, coming of a new generation of teachers.

In 1999 Polish structure educational system was transformed from the one used from 1961 into a newly designed shape more adequate to the needs at that period[11]. Among many results of that transformation there were two which stimulated development of new teaching models.

In newly formed lower secondary schools (12-16 y.o. students) lectures and demonstrations were not effective enough and more active methods were needed. On the other hand a new system of professional promotion was implemented and teachers were stimulated to train and to acquire new competences. The third factor was "educational project" as a compulsory element of teaching in lower-secondary schools.

According to the research made by ORE[12] and IBE[13] models 4, 5 and 6 (collaboration, inquiry, direct) are now much more popular in teaching STEM. Still the most common method of teaching is textbook-based and lecture, but the participation of more active teaching patterns increased.

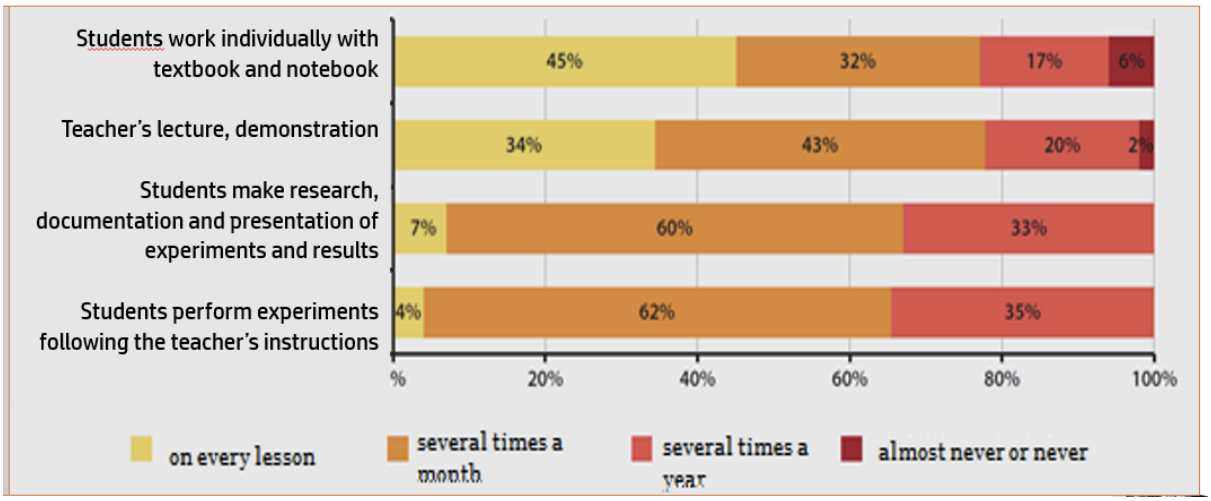


FIGURE 3: TEACHING METHODS USED IN STEM BY POLISH TEACHERS

It must be remembered that diagrams and surveys give the vision of an "average" teacher. And yet among teachers there are a lot of passionate professionals, innovative and efficient. In the Mazovia region there are over 150 innovative curriculums for physics written and implemented by individual teachers.

According to the report "average" teacher do not value team work and skills trained in it. They prefer to control the whole class. They are afraid that weaker students would "hide" behind their more competent friends, and students would not be able to get the proper results and mistakes can occur. There are difficulties in organization of more active kind of lesson: 45 minutes is not enough to perform all the stages of team-work based lesson.

The diagram below shows what kind of students behaviour is valued by science teachers.

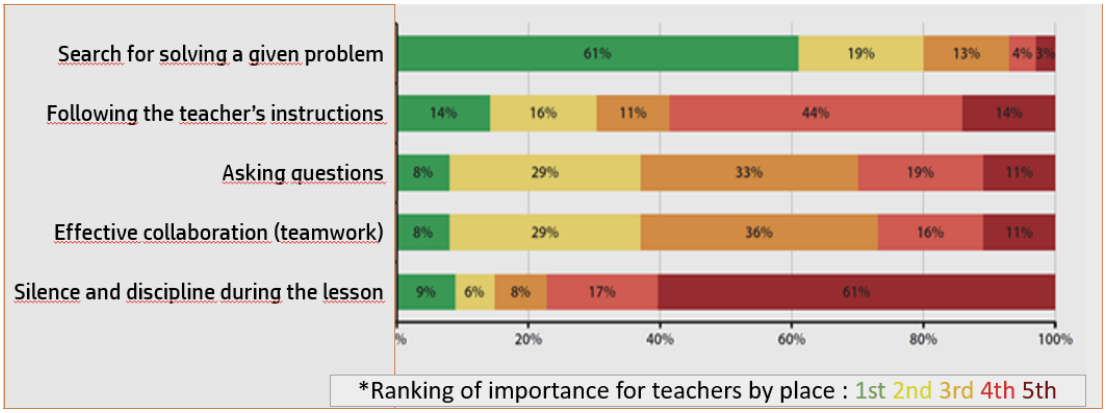


FIGURE 4 RATING OF STUDENTS' BEHAVIOUR BY IMPORTANCE FOR TEACHER

Another point of view is provided in the same report but with the results of research made among students. The questioned students claim that over 60% of teachers encourage them to ask questions. Only 22-26% of students declare that they do not participate in discussions during the science lessons. Due to these reports there is a strong parallel between the teachers' and students' points of view.

Active teaching methods.

Along with the changes of schooling organization in 90s the Ministry of National Education introduced a new system of professional promotion of teachers. As one of results teachers participated in a big number of trainings to fulfil the promotion requirements and pass teacher's exams. The market of trainings was evolving quickly with commercial companies, public institutions, universities and many more institutions offering trainings of all kinds. Among them the most popular were active methods of teaching.

As the effect of the 90s reforms of education two main results were achieved:

- a great number of teachers were trained,
- in the lower secondary schools the new competences were quickly and naturally implemented,
- the most innovative teachers were placed in lower secondary schools.

The present situation shows that most of teachers know and use active methods of teaching such as[14]:

- team work,
- simulations,
- games (goose games, role playing games),
- theatre, staging, drama,
- discussions and debates,
- brainstorm (being the most popular method of all),
- interview,
- quiz,
- resource analysis,
- study of a case,
- decision tree,

- mind mapping,
- voting,
- civic writing,
- excursions, visits in locations,
- portfolio, exposition.

These methods are used mostly during the lesson as a supplement of lecture or textbook-based learning. Moreover, they are an important part of project based learning.

ICT competencies

Furthermore, with quick implementation of ICT in schools, teachers began to use technology. Paper documentation is being replaced by online journals. Over 90% of teachers use presentations in their teaching and the recourses from the Web.

In a report by P. Siuda "New media in Polish school" [15] three main factors are significant for ICT implementation in Polish schools:

1. Almost half of all the teachers do not use the Web to contact their pupils and send them materials:
    - never: 46,9%,
    - once a month: 20,7%,
    - once a week: 16%,
    - 2–3 times a week: 9,8%,
    - every day: 6,6%.
2. Much more intensive teachers' use of the Web concerns searching for learning materials:
    - every day: 40,4% of teachers,
    - 2–3 times a week: 39,3%,
    - once a week: 11,2%,
    - once a month: 5,4%,
    - never: 1,8%.
3. In Polish schools there is in average 1 computer for 8 students.

In their private life Polish teachers are the most intensive users of ICT in UE[16]. But Polish schools have the worst result in OECD in using IT. The statistics concerning students also show a significant disproportion between usage IT in private life and for education:

- 99% teenagers have access to a computer at home,
- 97% have access to the Web every day,
- over 50% of Polish teenagers uses IT for more than a half of their lives,
- 88% use computer to communicate.

For educational purposes computers are used mainly as text editors and for making presentations while coding is still a rare competence.

Polish teenagers have good results in ICILS in ICT competences but it is because they use technology in their private life. Polish students got 501 points (30 over the OECD average). Girls, students from big cities and from well situated families have the best results.

The usage of Web resources in active teaching increases but still it is mostly passive usage with small interaction. Interactive educational apps, social networks, blogs and flipped classroom are used very rarely. There is a tendency to include this methods of using the Web. The factors which stop the process are:

- low quality of IT equipment in schools, unstable Internet connection,
- too small number of computers/tablets,
- satisfactory efficiency of non-technological methods of teaching.

On the other hand there are factors stimulating the implementation of interactive apps: training programs (by the Ministry of National Education, by local institutions, by UE programs like eTwinning), infrastructural programs (like "Digital School" in 2015), and the effort of local authorities to provide the schools with proper facilities.

According to the reports there is a big enthusiasm in declarations of teachers for using ICT but very insufficient support from the headmasters. Usage of ICT is not an important factor for promotion, increasing wages or other forms of reward.[17]

Cross-curricular competencies

In Polish educational system strong emphasis is given to the subject based education. A lot of teachers have just one specialization (or two close specializations) and the educational system before 2017 was adapted to this. It was a consequence of teachers training system. To become a teacher in most cases it was required to finish a University with a specialization and attend to additional teaching courses during or after studies. In consequence the teachers are specialists in their disciplines but have low level of cross curricular knowledge and skills.

The system mirrors this situation with the pupils' competencies. Although in theory cross curricular competencies are important to be acquired, they are rarely required from students. The teachers, having themselves low level of cross curricular knowledge, are reluctant to include it in their teaching process.

There's only small correlation between the curricula of particular subjects. Although on every level of education project-based learning is provided it is rather rare to perform a cross curricular project. Most often one discipline is dominating and other are just extras, with low level of proper knowledge or skills. The interdisciplinary teaching is performed in early school education, but neglected in lower secondary and upper secondary schools.[18] An exception refers to language education, where often various disciplines are mentioned and used. It is perceived that science subjects are perceived to be more "closed" for other disciplines, while social, humanistic and art subject have more tendency to "cross".

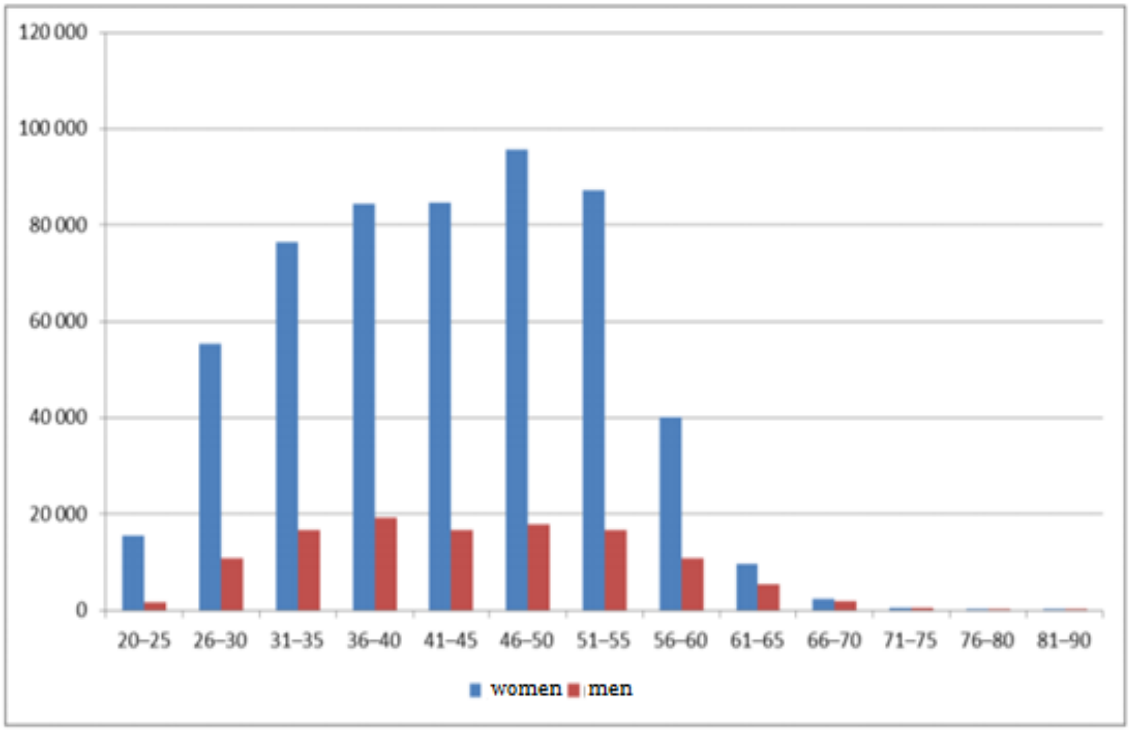


FIGURE 5 TEACHERS BY AGE AND SEX IN THE SCHOOL YEAR 2014/2015

Physics as an object of teaching

The present system

In the present system of education physics as an independent subject appears in the third stage of education (lower secondary school) and continues on the fourth (upper secondary school). In lower secondary school and first year of upper secondary school, the student is obliged to attend physics class in the elementary level.

In lower secondary schools the there are three years of physics as a subject. After this stage of education the student takes a compulsory exam. The exam consists of several parts. One of them is a Natural Science part where the knowledge and skills in biology, chemistry, geography and physics are tested.

In upper secondary school, physics is compulsory for all students in the first grade, and in the second and third classes, the student may choose it as an extended subject. In most cases the choice of extension in physics is related with the type of high education planned by the student. After the completion of the extended course, the student may take the matriculation exam at an extended level only, and the result of this examination is taken into account when recruiting at tertiary institutions of higher education (universities set their own conditions for recruitment).

The educational system after the 2017 reform

After the reform, starting September 2017, the former system (with lower and upper secondary schools) will only last for students who started their secondary education till 2016. They will follow the core curriculum and education schedule from before the reform till the end of their secondary education.

Students who finish the sixth grade of primary school in June 2017 will move to seventh grade (instead of moving to the lower-secondary), where the new core curriculum will be implemented. Eighth graders of primary schools will be able to choose physics from the 2021/2022 school year on a compulsory eight-grade exam. The results of this exam will be one of the criteria for recruiting to secondary school.

In a four-year general secondary school, physics will be compulsory for all students for the first three years of study. Moreover, extended four-year courses will be available for students.

Core curriculum

In lower-secondary education most of the fields of physics are implemented. The remaining three fields are implemented in the first grade of upper secondary school. So it can be said that the physics program in lower and upper secondary school is linear. This is a significant change compared to the spiral teaching of physics in earlier years (before 2008), when the issues were repeated on every level with gradation from basic to detailed learning.

Another change introduced in 2008 was the emphasis placed on the qualitative description of physical phenomena and the "trimming" of their mathematical description. More attention was also paid to the role of experiments in physics: experience planning, instrument selection, autonomy and the development of experiments, with ICT used where possible. The mathematical formulas were introduced as a summary of the known relationships between physical quantities. The core curriculum also assumes the training of text analysis skills, including popular science. The aims of teaching physics at the basic level in this core curriculum (2008) were developing students' research skills and encouraging to take physics at an extended level.

The extended level of teaching physics

In the second and third classes of the upper-secondary school, if the student chooses extended physics, the core curriculum assumes the completion of all previous modules complemented by the extending content and the improvement of the skills acquired earlier. At this stage, the main assumption is to teach the quantitative description of physical phenomena using a more advanced mathematical language. Comparing the content of the curriculum with those of previous years, it is clear that some of the issues of contemporary physics (relativity, semiconductors and their applications) are not included. This is due, among other things, to the difficulty of the problems, to the inadequate presentation of them in school programs, the separation from everyday life - the special theory of relativity).

After the reform in 2017[19]

The new core curriculum for the primary schools practically does not change the content of physics education followed in lower-secondary education, but only moves them into seventh and eighth grade primary schools. However, some issues were reduced in primary education and transferred to secondary schools. Moreover, there are evident changes in cross-sectional and experimental requirements. The estimation of the order of magnitude of the result and the drawing of graphs are no longer required. Planning experience, choosing the right measurement tools, measuring some physical quantities, has been replaced by performing selected observations, measurements and experiments just following instructions. Moreover several experiments (conducted in the lower-secondary schools) have been removed from the teaching process. More often the pupil is required to demonstrate (which is more passive) than to measure or determine phenomena (more active).

In secondary education the core curriculum for vocational schools, with one-year physics course, remains identical as it was till 2017. In the moment of closing this text (May 2017) the core curricula for upper-secondary schools are not yet announced, but the main aims are already known.

The schedule of teaching physics [20]

In lower secondary schools there are 4 hours of physics in an educational cycle, and the headmasters are free to divide these hours adequately to the school needs: 1+2+1, 1+1+2, 2+1+1. The most often followed schedule is with 1 hour per week in the 1st grade, and 2 hours per week in the 2nd and 1 hour a week in the 3rd grade. The correlation with teaching mathematics is optimal in this schedule.

In the 1st grade of upper-secondary school one hour per week of physics is required. For the 2nd and 3rd grade of upper-secondary school the students choose the subjects for extended level. The number of teaching hours per week varies from 4 to 5 in different types of schools (general, technical, academicals, other).

At the moment of closing this analyse the new schedules of teaching are known to be completed and awaiting to be approved by the Minister of National Education. However, the ministerial experts have started the information campaign with conferences and seminars for teachers, headmasters and educators. According to their information:

- in the primary schools the hours of teaching physics will be scheduled as 2 hours per week in 7th and 8th grade,
- in the general upper-secondary schools the teaching of physics on the basic level will be scheduled as: 1 hour per week in the 1st and 2nd grade and 2 hours per week in the 3rd and 0 on the 4th grade.

The physics textbooks

According to the recommendations given by the Ministry of National Education the physics textbooks have to provide a big number of experiments' descriptions where everyday items are used. That enables pupils to perform the experiments in small groups or even at home. All textbooks are designed with greatest care for graphic layout with a lot of illustrations (3D also), photos, examples, quotes, etc. The publishing houses offer not only textbooks but the big spectrum of other materials and facilities as "educational pack":

- For students: workbooks, tasks sets, worksheets, e-books, CDs,
- For teachers: result plan, teaching schedule, evaluation proposals, methodological guides (including lesson scenarios), test generators, test database, other apps, educational movies, animations, access to educational platforms and trial tests.

Although there is a wide offer from the educational publishing houses, there are two of them which are chosen most often. Their offers have variants for basic and extended level and for special education needs.

In the moment of closing this analyse only two textbooks of physics (and curricula related) have been approved by the Ministry of National Education for the newly reformed system and published. They are based on the former versions but there are significand differences due to new regulations. Some parts of content have been removed or described as "extra". More detailed explanations provide better correlation with mathematics. Although the new curriculum reduces the number of experiments, the most popular publisher "Nowa Era" decided to provide even more experiments' descriptions in the textbook.

The correlation between STEM subjects

The correlation of subjects is necessary on every level. In the existing system it is provided in most of cases. There are some difficulties where the mathematical skills are needed in physics earlier than they are introduced on mathematics lessons. The content does not repeat on different subjects. However, when the issues are connected with two areas they are often introduced on the basic level on one subject, and then extended in another one. For example: the Solar System is introduced on geography lessons and the on extended physics, while the eclipse is firstly described on physics and then on geography lessons. All the curricula of STEM subjects emphasize the real life context and cross curricular aspects as well as using various sources of information.

After the 2017 reform this correlation should be kept but not always will be. At present, the core curriculum of mathematics and natural sciences is known for primary schools. For secondary schools, only the core curriculum of mathematics is known and main aims for other subjects are given[21]. According to these the issues related to functions and their graphs, inverse proportionality or solution of linear equation systems with two unknowns will be implemented in secondary school. This will be a big problem in teaching physics or chemistry in primary school when a pupil is required to: use the Pythagorean theorem, construct charts,

tables and schemes based on available information as well as determine the change of velocity and acceleration from the velocity or time dependence graphs for the linear motion of a uniformly variable (accelerated or delayed). In consequence the pupil will need on the physics lesson some mathematical skills he have not yet been given.

The role of experiments in teaching physics

The main aims of physics teaching are to make the students understand the phenomena occurring in nature, point out their examples and make practical use of them. The best way to accomplish this is to make experiments . The current core curriculum imposes the obligation to conduct experiments in physics classes (14 mandatory experiments in lower-secondary school) in the smallest possible groups. Experimenting in classrooms is not just about making the teaching process more interesting or activating it. It is intended to stimulate students' curiosity and primarily to develop research skills such as:

- putting hypotheses,
- developing research problems,
- planning experiments,
- experience phenomena,
- developing results,
- making documentation of the results in various forms,
- the use of terms accuracy of the instrument and measurement uncertainty,
- graphing the relationships between physical quantities,
- draw conclusions,
- verifying hypotheses,
- drawing up the experience report.

With regard to the possibilities of the pupils, crucial elements can be introduced even on the basic level. On the extended level, all components of the scientific research method should be practiced.

Conducting of experiments is also shaping cross-curricular skills:

- teamwork,
- communication,
- adherence to safety rules,
- diligence, accuracy, reliability,
- manual skills.

Experimenting is the ideal cognitive method that activates and develops the creativity of the students. The benefits of this method of working in physics classes are also appreciated by teacher development centres, physics institutes and textbook publishers. These institutions help teachers to enrich their own methodology by organizing conferences, trainings or projects on this subject.

Best practices in teaching physics

Supporting pupils with difficulties in learning STEM

Mathematics, physics and chemistry are considered the most difficult subjects. Pupils who have any kind school difficulties are most often having problems with learning STEM. An interview was made among the teachers in Warsaw on behalf on this report and following methods of giving support were mentioned:

- students may attend to extra classes (compensation or consultation),
- the tasks are explained to the student during the lessons and read aloud,
- the teacher makes schematic drawings on the whiteboard while lecturing,
- pupils having difficulties are more often making tasks on the whiteboard, assisted by the teacher,
- the pupils are evaluated with consideration of the recommendations given by the psychologist,
- the students have less tasks to make during the tests, the time is prolonged,
- the pupils may ask for explanation of the task during the test,
- the students who need assistance are seated near the teacher's desk or whiteboard (after consultation with the tutor, the parents and the pupil),
- the student's notebooks are checked by the teacher.

Project-based learning

Providing educational projects is an answer for existing need of deeper and more engaging education. In this method the teacher provides a scaffolding for the pupils and assists them while they are solving the problem given. The students have the possibility to ask questions, and are provided with tools to find answers and to use their knowledge in practice. Their learning is process-based. Students use and develop active ways of learning such as creativity, collaboration, communication, and critical thinking. This method allows to give the pupils an opportunity for using their imagination and creativity, building their social relations and having fun.

There is a huge variety of educational projects conducted in Polish schools: from short and narrow project to long, cross-curricular, interdisciplinary and international projects like eTwinning.

Inquiry-Based Science Education (IBSE)

The method has been introduced during the SAILS - Strategies for Assessment of Inquiry Learning in Science project for the Polish teachers. It is an inspiring way of teaching science by engaging pupils in designing and conducting their own scientific investigations. For primary school teachers, the open nature of IBSE proved to be difficult as they often lack experience in assisting their pupils during the different phases of an open project, such as formulating a research question and designing and conducting an investigation. However, physics discovered in this method can be a great adventure for a student: it does not stress, it

stimulates curiosity, it gives pleasure and satisfaction of discovery, develops creativity and positively influences the student's self-assessment. It can be applied to a lot of physics issues. The only shortcoming of this method is the lack of time: it is not always possible within 45 minutes, provoke activities, act, discuss activities, and conclude. Many issues of IBSE were included in the core curriculum introduced in 2008.

Peers educational workshops

In many Polish schools „special days" are organized several times a year. During these events students replace teachers and provide lessons or – more often – workshops for their schoolmates. The teacher encourages and supports pupils, but they are free to choose the subject and the topic they want to teach. The students conduct workshops always in small teams. This gives the opportunity to the more skilled pupils to use their talent and to use the knowledge in practice. More than anything they learn to perform experiments and to communicate. In bilingual classes (CLIL education) the peers educational workshops are often provided in the foreign language.

Reducing disadvantages related to teaching STEM

Social inequities in education are widely discussed in Polish public debate. As reported by "Amicus Europae" Foundation the educational system in Poland still is not reducing but reproducing gender disparity and social inequities.

Subsequent to the "educational boom" of 90s in Poland an inflation of certifications may be seen. The average level of education increased to 40% of young people taking up high education in 2016. In the same time the quality of education decreased and the certifications and degrees are less valued than before the boom. In order to gain a better position on the labor market young people are studying two or three specializations and continuing education for PhD degree. This options are achievable mainly for male students from better situated families, biggest cities and higher social levels.

Gender disparity

There are neither system actions nor official Ministry of National Education's programs dedicated against gender discrimination in STEM or in education at all. The impact of gender to education is widely discussed and the society is divided. The educational system, curricula and textbooks mirror this situation.

The research[22] made by "Fundacja Edukacyjna Perspektywy" shows the participation of women in STEM. The following diagram presents the percentage of women studying at technological universities.

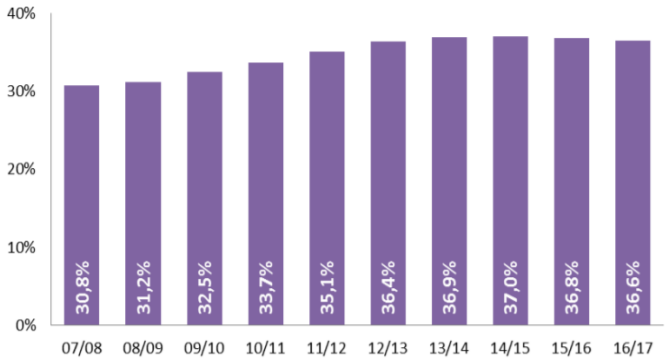


FIGURE 6 WOMEN ON TECHNOLOGICAL UNIVERSITIES IN POLAND 2007-2017 BY %

According to the report girls are neither motivated nor informed at schools about the possibilities of professional development in STEM and as engineers. A significant "mental change" is noticed in the report, too. The stereotypes of men-dominated jobs are getting weaker. Discrimination, iniquities and male domination are no longer important factors and difficulties for girls planning their career in STEM. However, these stereotypes and difficulties are still strong among older generations.

The gender pay gap[23] seems to be a significant problem with the highest level of women discrimination in the generation of parents and teachers (34-44 years of age).

FIGURE 7 GENDER PAY GAP BY AGE GROUPS 2014 (%)

Summarizing the research and reports mentioned above, three main factors should be noticed considering the iniquities in STEM education between boys and girls :

- 85% of Polish teachers are women in the age between 30 and 50,
- the stereotypes about women's lower abilities in STEM are strongest among Polish people aged 30-60,
- the male part of population is dominating in STEM professions with gender pay gap on the level of 23% in this sector.

Accordingly schools are reproducing the iniquities and the gender gap because the teachers represent the social group most influenced by gender discrimination. Pupils don't have large

number of examples of women's career in science, technology, engineering and mechanics (STEM).

However the gender pay gap is distinct in Poland, it is one of the smallest in UE [24]

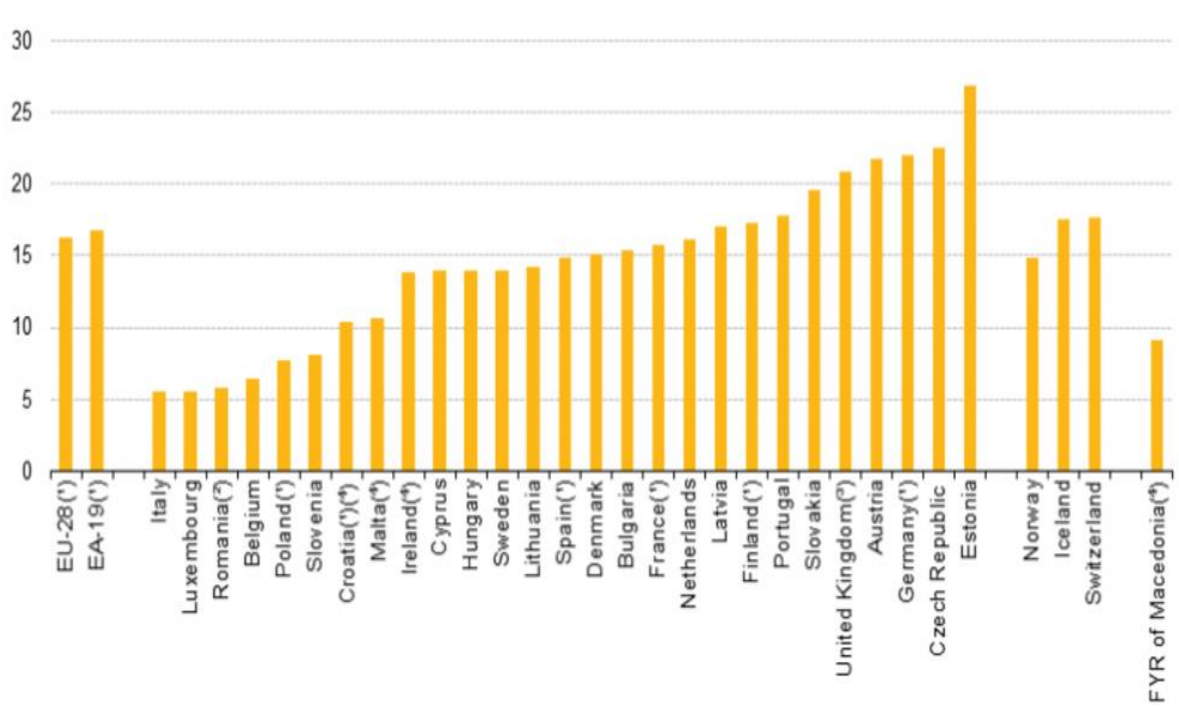


FIGURE 8 UNADJUSTED GENDER PAY GAP, 2015 (DIFFERENCE BETWEEN AVERAGE GROSS HOURLY EARNINGS OF MALE AND FEMALE EMPLOYEES AS % OF MALE GROSS EARNINGS)

Reducing gender disadvantages in STEM- examples of actions

With no official Ministry of National Education programs against gender discrimination Poland has a big number of actions taken by NGOs and supported by various institutions, including the Polish Government and UE institutions among them.

From 2007 till now *Girls as Engineers!* and *Girls go Science!* campaigns have been organized in Poland by the Perspektywy Education Foundation and the Conference of Rectors of Polish Technical Universities (KRPUT). The campaigns were very successful:

> *They have been very successful; the share of girls involved in the STEM-education in Poland increased during this period from 29% to 37%.*
>
> *Over 70 000 girls have participated in our campaigns. The main aim of "Girls as Engineers!" and "Girls go Science!" is to introduce technical and engineering studies to female high school students and to promote this educational path as interesting, attractive and very beneficial in the long run. It is also to show that technical studies address a recognized need of business and industry to attract highly trained workers with a variety of skills.*

"Girls as Engineers!" & "Girls go Science!" are run under the auspices of Minister of Science and Higher Education, Minister of National Education, Minister of Administration and Digitization; Minister of Labor and Social Policy, Patent Office and the Ombudsman. [25]

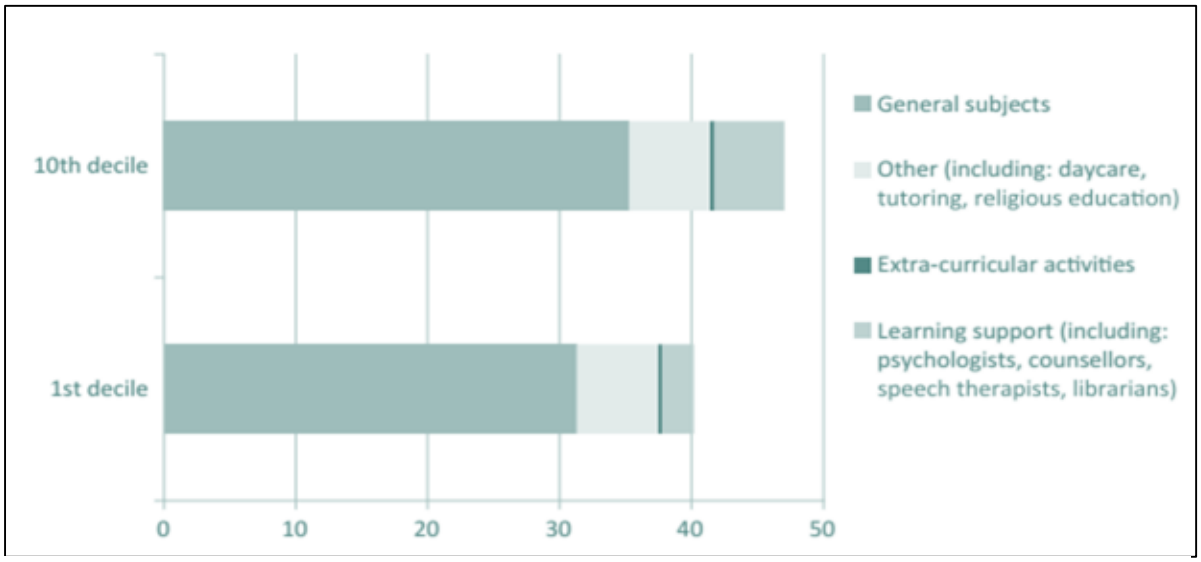


FIGURE 9 INEQUITY IN A DECENTRALISED EDUCATION SYSTEM: THE AVERAGE WEEKLY NUMBER OF HOURS OF TEACHERS' WORKING TIME CALCULATED PER UNIT IN GMINAS FROM THE LOWEST AND HIGHEST DECILE, IN TERMS OF OWN REVENUE PER CAPITA- EVIDENCE FROM POLAND

Social inequities and their consequences for STEM teaching

Social inequities and disproportions in economic situation are strongly influencing education. Striking inequalities between smaller towns and big cities refer to the quality and availability of education. According to the report "Inequity in a decentralised education system – evidence from Poland" by Mikołaj Herbst, Anna Wojciuk from Educational Research Institute, decentralized financing of Polish schools has an important impact on the territorial differentiation of expenditure, which in turn translates into differentiation of educational services.[26]

The education subsidy covers around 70% of total schools' expenditure. The remaining 30% is covered mainly from local governments' own revenue and other financial input from the central budget. Own revenue is raised by local taxes, sales and rental of property, and from the local government share in personal and corporate income tax. Subsequently the rich and highly developed regions can afford better schools, with better paid teachers and modern facilities while poor regions are struggling to provide the basic level of educational services. Better teachers are "escaping" to bigger cities in rich regions. In consequence the differences are set to be deeper. Nevertheless the compensatory subsidy is provided by the central government for the municipalities having financial difficulties in covering the needs of education.

Although the education is in theory provided on the same level and students are having the same schooling conditions, in practice the differences are significant. The cities and municipalities having better financial conditions provide the bigger number of extracurricular

lessons (compensatory and innovatory) and smaller groups instead of big classes. Specialist can be hired such as counsellor, psychologist, support teacher, speech therapist.

As the education system is decentralized in every district there are different ways of solving and preventing social inequities based problems. Apart from actions inspired by the Ministry of National Education and by local authorities there exists a large number of independent programs and actions taken by various institutions. On behalf of this report a number of most significant examples was selected.

"Increasing of pupils achievements - a vision for European schools"[27] is an Erasmus+ KA2 project of the Warsaw Centre for Socio-Educational Innovation and Training in partnership with Cardiff Council (UK) and the city of Ferrol (Spain). The main objective is development of educational innovations in teaching science, and especially in mathematics.

"Polish Children's Fund" - *"The Polish Children's Fund is an independent, non-governmental organization established in 1981. One of its major objectives is to help exceptionally gifted pupils and students develop their academic interests and artistic talents, and to adjust the educational system in Poland to accommodate the special needs of the highly gifted."* [28]

Supporting children with special needs and specific learning difficulties

In Polish schools the system of supporting pupils with difficulties and special needs evolved continuously. Besides providing the educational services schools are considered to be the "first aid" institutions of reaction and support in problems. The process of providing help is based on the cooperation of the class tutor, the parents and the school pedagogue.

On every stage it is possible to find and provide the adequate solution without proceeding further steps. The class tutor, the parents and the school pedagogue are observing the child and the problem solving process. Other teachers are informed and engaged adequately to their concern and reference to the problem.

In most cases the parents undertake recommended actions and cooperate with the school pedagogue. However, if the problem continues and the parents do not follow the recommendations, the problem is reported to the Social Welfare. A supervisor is assigned to the family in that case and further steps are controlled by the Social Welfare Institution.

In most cases the child remains in the same school and class. If the process of assisting the child in his/her difficulties is performed without obstructions the following methods of support may be applied:

A. Medical treatment is applied.
B. Economic support is provided by the Social Welfare.
C. The child is provided with extra activities supporting it in difficulties. The activities take place:
    a. In external institutions:

- Dayrooms – under care of local authorities, independent organizations, church, charity, volunteers,
- Psychological-pedagogical counselling,
- Commercial educational institutions.

b. At school:
- Compensatory activities with the school staff, regular,
- Occasional consultations with the teachers or pedagogue.

c. At home:
- Specific exercises supervised by parents,
- Extra payed private teacher.

D. Adequate methods of work are recommended to all the teachers. The teachers are obliged to adapt the teaching process to the individual needs of the child.
   a. In health-based problems the child is released totally or partially from the sport activities. The teachers are instructed how to assist the children having specific diseases and health problems;
   b. In case of temporal disability (accident, transplantation, other) the pupil is provided by school with individual lessons with teachers visiting at home;
   c. With medical or psychological recommendation the child is provided with individual lessons at school;
   d. An assisting teacher may be assigned to a disabled child;
   e. The child's time for tests and assessments is prolonged;
   f. The form of tests and assessments may be modified according to the recommendations;
   g. The teacher assists the child during the lessons individually.

In special cases the child is placed or transferred to another school.

a. Special needs school – usually boarding or half-boarding;
b. School with integration (supportive) classes;
c. Youth Education (Resocialization) Centre - usually boarding or half-boarding.

The process and methods presented refer to the system in its theoretical assumptions. It's effectiveness is determined by many factors. The role of school pedagogue is of highest importance. But, according to the Teacher's Chart[29], the employment dimension for the pedagogue is not determined by the number of pupils. It is due to the headmaster and the govern body of the school to employ one or two pedagogues or a psychologist. The number of pupils under care of only one school pedagogue differs from 153 to 677 in Poland[30]. Furthermore, 76% pedagogues are not full-time workers and have to work as subject teachers to have the full time job. Their work is less effective too because they are obliged to do a lot of non-pedagogical work: communication management, health and safety control, administrative work etc. In the schools having good economical basics, in prosperous regions and cities, the local authorities provide financial resources to employ more pedagogues and psychologists.

a child's problem			
reported by the class tutor/teacher	reported by the parents	reported by the child	
the child speaks with the school pedagogue		the child is interviewed or observed by the tutor	
↓	the parents are contacted and interviewed ← or ↓	the child is consulted with a school or psychologist (optional) → or ↓	↓
↓	the school pedagogue decides about the adequate path of providing support. Further steps are recommended to the parents. The headmaster is informed.		↓
↓	↓ the police and the family court are informed	↓ social welfare institution is informed	↓ the child visits a psychological-pedagogical institution	↓ The child visits a physician or a psychiatrist	↓
	the child or the family is given a supervisor or assistant ↓	a social worker diagnoses the problem and recommends support: educational, social, or economic. ↓	the child is given a detailed description of special needs and specific difficulties with detailed recommendations of providing support for the parents and teachers ↓	The treatment is recommended; it is due to the parents to organize the treatment process. ↓	
a solution is found and adequate steps are undertaken at home and school					

TABLE 6 THE PROCESS OF SOLVING PUPILS' PROBLEMS IN POLISH SCHOOLS

Conclusions

Polish educational system is developing dynamically. In the last 30 years a lot of changes happened, and in 2017 there is a revolutionary reform ahead of Polish schools. As was showed in the reports and the analysis Polish education meets European standards. The results of Polish students are comparable with their peers from the most advanced countries of the UE. But there are still a lot of factors that require concern.

Among these concerns a significant factor is the low usage of ICT in education. Although in private life Polish teachers and students are competent users of computers, smartphones and apps, they are not transferring these skills to the professional and school activities. The main reason is the low quality and accessibility of ICT facilities at schools. Consequently a huge potential of pupils and staff is wasted. On the other hand Polish teachers developed an impressive number of non-technological methods of teaching, which proved to be affordable, available and effective. Taking account of the experience of French and British teachers it should be considered how important the implementation of technology is. There should be a balance found between technological and direct methods of teaching and learning. Polish teachers should accommodate the ICT well enough to use it effortless. Technology should support active teaching and be always used on purpose.

Another important conclusion of this Analysis is the calling need of sharing educational achievements among Polish teachers. During our research we found out that in Poland there exists a huge amount of best practices (educational projects, educational innovations) but they are not released, published or shared. A great number of innovative teachers in STEM and other disciplines developed modern, creative, interdisciplinary and effective methods and use them every day. It is a great advantage of "SAT Project" to collect these best practices, to award the authors, and share with the public in the way most adequate for teachers to use. It is important as well to activate teachers and educators and encourage them to develop more innovative practices.

The Analysis proved to be a valuable source of knowledge about the Polish Educational System in a very important moment when a big reform is implemented. We hope that this publication and the results of SAT Project will help Polish STEM education to develop, to prevent the mistakes and to implement widely the best practices of Polish and European teachers.

INDEX 1. Graphics, figures, tables

INDEX 2. Abbreviations

IT – Information Technology

PE – Physical Education

ICT – Information and communication technology

CLIL – Content and Language Integrated Learning

STEM – Science, technology, engineering and mathematics

ORE – (Ośrodek Rozwoju Edukacji) – Center for Education Development

SAILS - Strategies for Assessment of Inquiry Learning in Science

IBE – (Instytut Badań Edukacyjnych) - Educational Research Institute

NGO – Non-governmental organization

IBSE – Inquiry-Based Science Education

ICILS – International Computer and Information Literacy Study

OECD – Organisation for Economic Co-operation and Development

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