



MATEMATYKA się liczy

Reasoning, Modelling and Communication in Classroom Mathematics

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In the recent years in Poland there have been numerous discussions concerning the well visible crisis of the mathematics in school and the question was: **is this a crisis of math in school or in society?** The last decade brought quick and violent changes of life in Poland in all respects. Not only school and education have been changed. Such situation resulted immediately in a deepening discrepancy between the expectations and the social needs on one hand and the school and the effects of education on the other. Teaching of mathematics started to be perceived as completely separated from life art for art's sake. The need for change became priority. In the year 2000 a broad educational reform started. New rules of school functioning were introduced. In the framework of the reform new curricula and new textbooks appeared.

These changes and challenges concern mathematics as well. We faced the problem of preparing new content to teach mathematics according to the social expectations. But what is modernness in mathematics on the school level? In Poland, there is a strong tradition of the Polish School of Mathematics, based on mathematical logic and theoretical approach to mathematics. How to reconcile tradition, habits and the existing base of teachers with requirements of modernness?

The social expectations in concern to mathematics mean making the maths more real, its submerging in the everyday life and its problems, such teaching that helps everybody to learn how to use mathematics to solve problems standing in front of him. It is also the skill to making use of new technologies.

The Project *Maths Counts*, a modern content supporting teaching of maths in the 3-year reformed lyceum (upper secondary), is an attempt to find a solution to this problem. The Project has been prepared by a group of 8 authors for the WSiP Publishing House. The authors consist of the academic as well as school teachers.

Mathematics is a scientific domain, rich in notions, theorems and methods. It is at the same time a domain of human activities, a way of describing the world and communicating with it, a comprehensive tool supporting human activities. These aspects of mathematics, the fact that it penetrates the whole sphere of life, we wanted to show in the Project. In this background, we wanted to present the elements of knowledge respective to mathematics.

This assumption has led us to distinguish in Mathematics three main threads, three instantaneously mixing colours that form its spectrum. We called them: **Reasoning, Modelling and Communication**. **Reasoning** is a fundamental instrument of mathematics. It enables to notice relations among the notions. Thanks to the reasoning, new theorems and formulation of investigated objects properties are created.

Modelling connects mathematics with the “outer world”, because its applicability results from the possibility of creating mathematical models of phenomena and investigating of the models by means of the methods specific to mathematics.

Finally, **Communication**: mathematics is also a specific language, in which information of the world is transferred and the obtained results are expressed.

In our material, the division into the above mentioned three categories does not exist, it is not possible to introduce such a classification. Instead, didactical problems are used to emphasize these threads. Some problems can be better used to stress the role of reasoning, the others are good to show the essence of modelling, another ones pay attention mainly to the way of communicating the results. It is clear that the classes of “reasoning”, “modelling” or “communicating” are not recommended, on the other hand, it is important to show the fundamental nature of each of the three aspects, but also of their interlacement in all mathematics.

Maths Counts is based on **problems**, around which the essence of teaching is grouped and which we called **tools**. The **tools** are chosen for each **problem** and it means that, on one hand, in the frame of one problem, various tools can be used (algebraic as well as geometric ones) and on the other hand, the same tools are used in different situations (functions being a good example). Therefore, we start from a problem and then, constructing a suitable model, we select tools that ensure to get a solution. Presentation of the teaching essence is done by means of **didactical actions**. Proposals of such actions are presented and they are formulated in a shortened way, very often basing on an example illustrating the subject under discussion. Thus, investigation of sunrises and sunsets, motion of a pendulum, tea cooling process or economic analysis of enterprises are not complicated theories but examples of certain functions, links etc. The choice of these examples reflects our main assumption: **mathematics penetrates the reality and it is worth while to discover mathematics in it**.

An important element in the project *Maths Count* is the use of modern technologies. We usually point to the place where technologies are used in the materials. Sometimes it is the use of an ordinary calculator to perform the boring calculations, sometimes graphic calculator or computer are used. Calculators serve not only to perform calculation but also as a tool supporting and enabling investigations, checking and experimenting.

Our proposals of textbooks allow to teach lessons without using technology, but we underline that the use of technology enriches the didactical process a lot.

We also prepared proposals of long term assignments, projects enhancing the use of technologies.

An important part of education is the use of Internet. The materials in writing are accompanied by materials coming from Internet. Some of them are constant and do not change, the others are introduced successively. Supplementary content, problems, tests, scenarios of lessons for teachers, examples of working with computer or calculator, interesting links are presented there.

The project *Maths Counts* was based on the assumption that **mathematics is a tool as well as a part of the education process**. We think that, basing on this assumption, the teachers can easier accept the use of new technologies that help students to investigate and in consequence helping them to build their knowledge.

The modernness of the Project comes into view in some parts of the content that were not included in the teaching of mathematics before, such as e.g. descriptive statistics. The content is completed by an analysis of problems existing in our life: economical, health care, population problems, etc.

The Project *Maths Counts* was prepared in two versions: Basic and Extended ones. The Basic version is more oriented towards the practical part of mathematics. Whereas, for those who can see the beauty of mathematics, who can be fascinated by the strength of theorems and enjoy the reasoning leading to their proves, the Extended version is prepared. We do not resign in this version from the practical function of mathematics, since such

mathematics is needed for all. We are trying to show something more: abstract questions concerning important parts of mathematics are being asked more often. We present also mathematics as a domain of self studies (reasoning) and a place for searching relations among the well known real objects (modelling and communication). There are more abstract notions, we emphasize more such purely mathematical activities as proving theorems or constructing abstract objects. The aim of such approach is twofold. First, to refer to tradition of Polish mathematics, to teach abstract thinking and to encourage to deeper studies of mathematics and other subjects based on exact reasoning. Second, to give even better, broader base for application of maths in everyday life, to solve even complicated problems.

The material of the Project consists of: a textbook for students and a book of problems in two versions, methodical guide for teacher and material in the Internet.

All material is constructed in such a way to be able to fulfil a fundamental requirement in didactics of mathematics – students learn and construct their mathematical knowledge through acting. *Maths Counts* demand from the students **inventive and creative attitude**, a lot of activity in abstract thinking as well as in collecting data and information.

Chosen fragments of the material for students were tested by approximately 50 teachers in schools.

Many concepts of the Project *Maths Counts* can be explained by the name itself and by the chosen logo: nine dots in the form of a square.

Let us look at the logo. On one hand, the dots can be easily counted and a geometric shape can be seen. On the other hand, it is an illustration of an old, well known theorem: sum of consecutive odd numbers is a square of a number – to 1 we add 3, then we add 5, then 7, ... and it is seen that the result is always a square. We have here: counting, reasoning and transmission – that is communication. Clear and readable transmission, not lost in an excessive symbolism and formalism.

The Project *Maths Counts* is, as it was supposed, a vivid and under constant development project.

We plan and foresee a successive creation of accompanying material, being an effect of cooperation of the authors and the editorial office with various workgroups, local and international, dealing with improvement and modernisation of mathematics teaching on the upper secondary school level. The material can have a form of textbooks as well as the Internet publications.