

The Mathematics Education into the 21st Century Project
The Future of Mathematics Education
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Modern mathematics schoolbook in Poland in 21st century – what should it be like?

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Abstract: In this presentation I shall briefly analyze, what we could consider to be a „modern mathematics schoolbook”. I shall discuss successive principles and requirements, substantiate them and present examples of old and new texts from various schoolbooks.

It was not so long ago in Poland, when on every level one and just one schoolbook on mathematics was obligatory. It was unimportant, what school it was - either in a huge urban housing estate or a small community school - the same schoolbook was obligatory everywhere. We used to complain very much: of the limitations, of the inadequacy of texts to situations, to students’ capabilities and to their expectations. We considered our schoolbooks uninteresting, too traditional, not modern.

At last, on the threshold of the 21st century we have seen the education reform happen. The school system has changed, the principles of work, the syllabi. Diversity of schoolbooks is admissible.

Now we also complain – perhaps even more than before. The diversity of schoolbooks is very tiring. We have to select the one, with which we shall work. Therefore we have to take into account many criteria and select the one, which in our opinion is the best.

In the documents pertaining to the Education Reform, in many articles and during courses - one of the most frequently repeated definitions is „modernity”. We are to have modern schools, we are to teach in modern ways, we are to use modern helping tools. Consequently our schoolbooks are to be modern too.

For the first grade level of lower secondary school (*pol. gimnazjum*) we have now the choice of more than 10 schoolbooks.

For high-school mathematics, for the first grade we can select out of 22 schoolbooks.

Do all of them deserve to be called „modern schoolbook”?

If modernity is to constitute for us a criterion of selection, we should correctly answer ourselves the question: What in fact does a “modern schoolbook” mean to us?

Every schoolbook must be compliant with the Syllabus Core. It constitutes the foundation and contains guidelines for creation of syllabi and schoolbooks. Therefore one may state that a modern schoolbook is such one, which fully meets the conditions contained in the Syllabus Core. So let us examine school’s objectives and tasks:

Lower secondary school (pol. Gimnazjum).

Educational objectives.

1. *Preparing the students for being capable to use their knowledge of mathematics to solve problems within the scope of various fields of school education and everyday life: building mathematical models for specific situations.*

2. *Acquainting the students with mathematical language; capability to recognize and formulate, to solve and to discuss problems.*

3. *Building up the students’ three-dimensional imagination.*

School’s tasks

1. *Forming thinking skills and ability of clear formulation of expressions.*

2. *Building up the students’ skills with regard to understanding texts formulated in mathematical language.*

3. *Building up the ability to describe simple situations in mathematical language.*

4. *Making it easier to recognise the problems and to examine them in specific cases by conducting simple mathematical reasoning.*

Secondary schools (pol. ponadgimnazjalne)

Educational objectives:

1. *Formation of the skills to use the simplest abstract objects: numbers, variables and algebraic expressions built upon them, sets (of numbers, points, elementary events) and functions.*

2. *Formation of the skills to build mathematical models for diverse situations of daily life and to use them for solving practical problems*

3. *Formation of the skills to design calculations and to perform them.*

4. *Learning the basic elements of mathematical thinking.*

5. *Acquiring the capability of self-dependent attainment of mathematical knowledge.*

School’s tasks

The task of school is to help the students to achieve the indicated educational objectives, with particular consideration of:

1. *Ability of precise formulation of thoughts in speaking and writing.*

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2. Building up three-dimensional imagination

3. Ability of reading and presenting data in various forms (symbolic, graphical, by means of formulas)

4. Ability of utilising modern tools, which support solving mathematical problems (calculators, computers).

5. Ability of co-operation at problem solving.

One may state without doubt that a modern schoolbook is such one, which makes it possible, facilitates and contributes to achieving the above mentioned objectives and tasks.

So let us consider what conditions must be met by a schoolbook under these assumptions - how should it be structured and what should it contain?

It is very clear that a modern schoolbook can not be an academic set of mathematical contents only, given to students to learn. In order to achieve the above presented objectives a schoolbook must support the most important - and by didacticians recognised as the fundamental one - requirement of effective teaching - functional teaching. Besides, this functional teaching should be immersed in the real world surrounding us and connected with problems of our real world. Schoolbooks can not propagate mathematics as an abstract and formal science separated from the reality. On the contrary, they must point out the situations and problems from the real world, which have been successfully solved thanks to the application of suitable mathematical tools. These problems should elicit student's curiosity of getting knowledge of the world and its phenomena.

Therefore a schoolbook should contain references to various phenomena – frequently defined historically, which have been solved with the use of mathematics or in which the efforts to understand a phenomenon or to solve a problem led to getting knowledge of various mathematical tools. Student should also find in the schoolbook examples of problems, which can be solved by usage of these tools.

Consequently, we reached mathematical tools or, in other words, mathematical contents. This means: facts, theorems, formulas – i.e. what schoolbooks on mathematics have always contained. Let us notice, however, that now these facts should result from the situations, from the problems posed, from the adopted model.

The model, modelling is the next essential feature of a modern schoolbook. In the schoolbook a student finds a situation, a problem, which must be solved. Mathematics prompts with a way – at first build a model of the situation. When building the model, the student should be gradually guided by the schoolbook and not only use the tools already known - (which means to use the knowledge acquired so far) - but to carry out an analysis of the situation, comparisons with others, apply analogies. It is only after construction of the model, when the turn comes to learn new tools.

The above mentioned Objectives and Tasks of school lay strong emphasis on learning and using mathematical language, which means on proper communication. It is not enough to be aware of and to know something by oneself. It is equally important to transfer one's knowledge or one's considerations to other persons, to know, how to determine (define) the subject of a discussion. Therefore the schoolbook should provide students/teachers with situations, in which it is necessary to communicate.

Communication means here a clear putting forward of the problem, defining, formalising, arguing and convincing – which means participation in discussions over a mathematical problem. Such abilities will not be acquired by a student through a “giving” system of education.

The structure of a modern schoolbook should be such, in which mutual discussions among the students and with their teacher are planned and incorporated in the course of the class. In other words, work in groups should be anticipated in a modern schoolbook.

And yet the reasoning. A student who is being educated in a modern way must be able to think self-dependently, and not just to repeat and to reproduce. For the schoolbook it means that conditions must be created, in which it will be required from the student to consider his/her work, to analyse his/her activities, to analyse his/her understanding. The conclusion from the above is that a modern schoolbook, with which a whole group of students works, must at the same time make it possible to work individually. Everybody should have a possibility to find for himself/herself his/her own field for activity and for considerations - on his/her own level of understanding mathematics.

One may say that all these requirements depend on the teacher and that a good teacher, who teaches in a modern way is able to plan and prepare such classes: work in groups, joint problem solving, discussion, self-dependent writing of mathematical assignments.

Of course this is true, but it means a huge job for a teacher. In fact, a teacher has at first to plan and design, and subsequently to elaborate, his/her own materials for his/her own needs. There is a number of teachers who have such classes elaborated but generally for a few hours only. Schoolbook constitutes the teacher's main helping tool in his/her job and it should be elaborated in such a way as to contain materials for all

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classes. The schoolbook must guarantee to the teacher the foundation and safety of proper teaching for the whole year of his/her work in school.

The successive elements, which we have to recall are calculators, computers (including the Internet) and other technical supporting devices that are used in a teacher's work with his/her students.

If teaching is performed by means of traditional methods: chalk and board, we shall not get acquainted - neither ourselves nor our students - with the modern technology. This is why using modern technologies must constitute an integral part of a modern schoolbook. Students should compute with the use of calculators, avail themselves of various mathematical computer software, search for information in the Internet, print documents, make their copies as well as prepare mathematical projects and elaborate and perform presentations.

All these elements should be incorporated into the schoolbook's structure.

The last requirement with regard to a modern schoolbook is proper preparation to examinations. In the schoolbook a student should learn all types of examinations which he/she will face. This is not always possible, as examination rules and requirements are very unstable. But the Internet does exist. A modern schoolbook should have its reflection and support in the Internet - additional tasks, problems, the place to present one's projects, updated information, including changes in examination rules supported by relevant examples.

As one can see, a schoolbook must fulfil many, not so easy, postulates in order to be worthy of the name of a "modern schoolbook".

It seems from this brief analysis that the most essential is the structure of a schoolbook, which must be based on completely different principles than the ones applied so far. The traditional schoolbooks, to which we are used, can not be adjusted to the new requirements, because it would be necessary to change too much in them.

Perhaps it is difficult to find a schoolbook, which would meet all the conditions specified above. But let us look among them for such ones, which meet most of these conditions. Our searching will become easier, if we realise that the concept of a „modern schoolbook” outlined above describes a schoolbook, which supports active and interesting teaching, open-minded to people and events.