Mathematical competence – do we know where we stand?

Mathematics, as one of the teaching subjects, has been facing great challenges for decades. On one hand, mathematics has been, and has to remain one of the essential teaching subjects which greatly contributes to the students' training and development, as well as to the reaching of the knowledge-based society. However, mathematics has constantly been under the impact of numerous factors which, each from its own perspective, do not want or cannot understand the significance of the good mathematics education for every individual in an economically developed society.

First things first, the importance of mathematical competence and mathematical literacy has been recognized in strategic and/or legal documents in a large number of countries. Eight key competences defined by EU include the following one as well

„The ability to develop and apply mathematical thinking and insight in order to solve a range of problems in everyday situations. This mathematical competence is based on the ability of reasoning and the application of numerical reasoning. Mathematical competence involves, to different degrees, the ability and willingness to use mathematical modes of thought (logical and spatial thought) and presentation (formulas, models, constructs, graphs, charts). It implies that an individual should have the skills to apply basic mathematical principles and processes in everyday contexts at home and work (e.g. financial skills), and to follow and assess chains of arguments. An individual should be able to reason mathematically, understand mathematical proof and communicate in mathematical language, to use appropriate aids including statistical data and graphs and to understand the mathematical aspects of digitalization. *A positive attitude in mathematics is based on the respect for truth and a willingness to look for reasons and to assess their* ***validity***.“

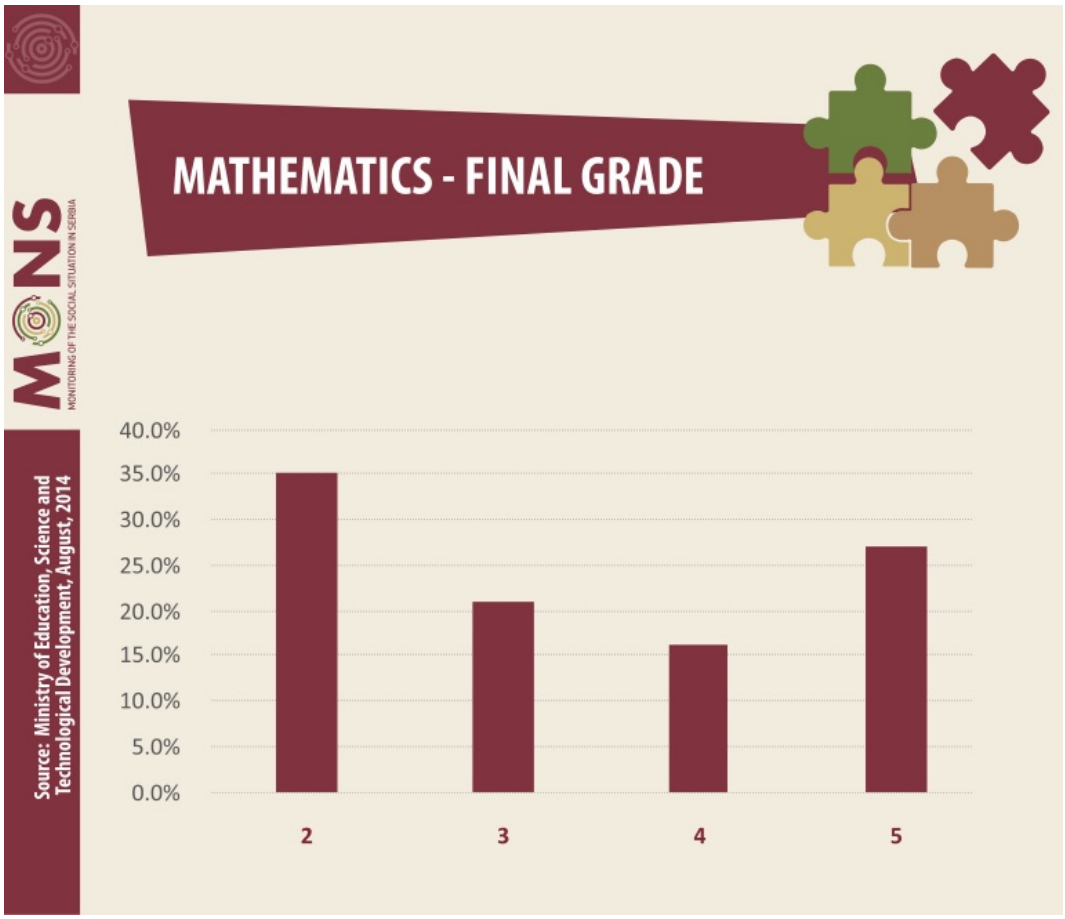
Mathematical competence has been embedded into the umbrella law governing the education in the Republic of **Serbia**.

If the mathematical competence is so important, the question naturally arises regarding the method of its evaluation. Can we answer the following questions: To what extent is mathematical competence developed with our students? What is the trend in achievements? Which factors have positive, and which ones have negative impact on their development? Do the reforms that we constantly hear about have any effect at all? Do we, and to what extent, achieve the goals of mathematical education defined in the documents? How motivated and prepared our teaching staff is?

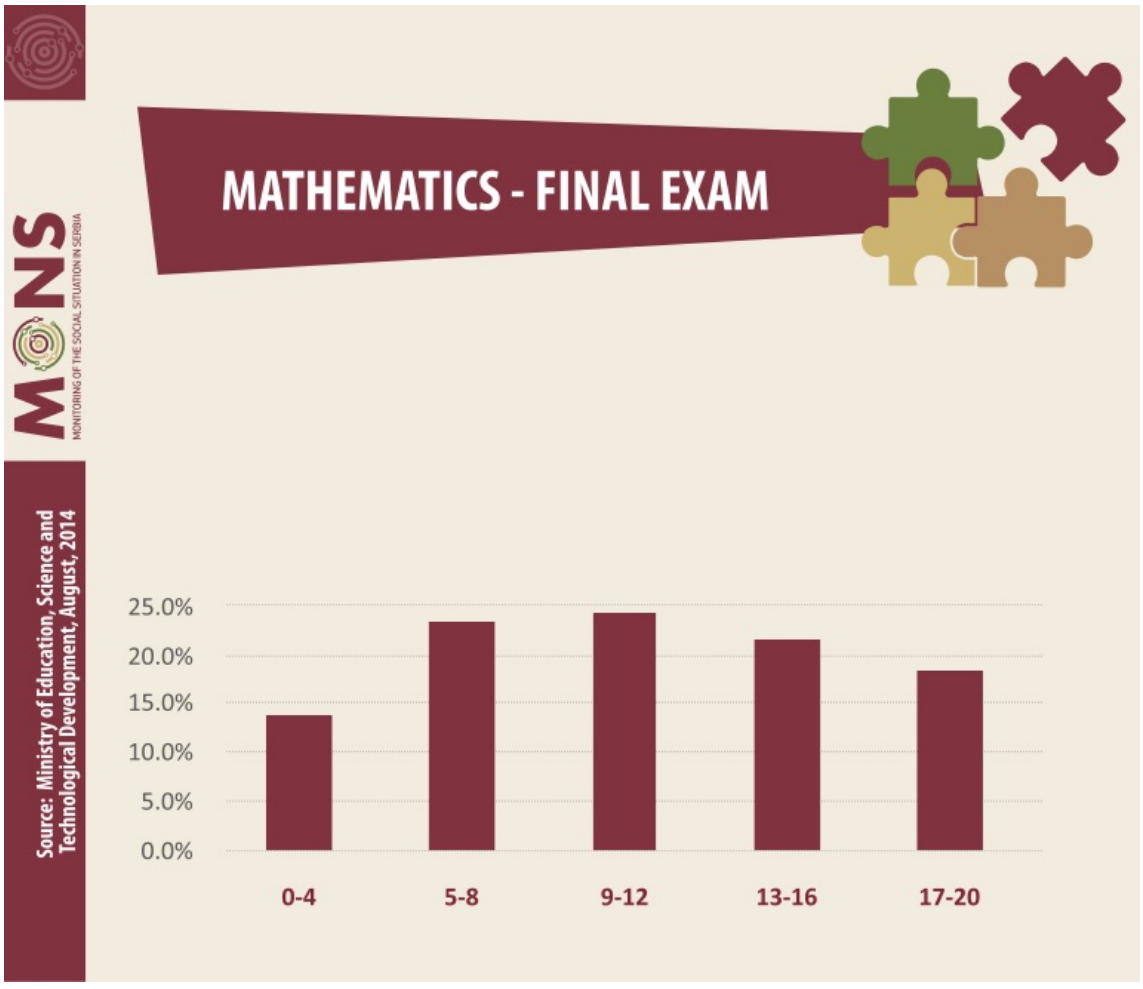
If I were to answer at least some of these questions, as a professional mathematician who deals with the mathematical education to a significant degree, I would find it difficult to give a (correct) answer. The reason for that is the absence of appropriate data collected in a relevant manner, by using appropriate methodology. This leads us to the paradox caused by currently available data related to mathematical knowledge, skills and abilities of our students.

The generation graduating from the eighth grade of primary school in 2014 was selected for the analysis. Since Serbia did not participate in PISA test in 2015, the last available valid data is the data obtained from PISA 2012, being the closest to the observed generation.

The first indicator of students' success in mathematics is the *final grade* at the end of the eighth **grade**. Despite the existence of the Guidelines on the assessment and the instructions for the **evaluation**, the distribution of grades leads to the conclusion that they are not usually applied. Namely, 5 (A) is the final grade in mathematics for over one quarter of students, 27.1%, which, based on the Guidelines, would mean that "*a student makes a very significant progress in mastering the curriculum and independently fully meets the requirements set at the basic and intermediate level, as well as most of the requirements set at the advanced level of special achievement standards*". Although the average final grade in mathematics for the entire student population (65,929 students) is 3.35 (C), U-shaped distribution indicates that the final grade cannot be an objective standard for students' achievement in mathematics. The hypothesis imposes that there is a significant number of "unjustified" Ds and As. The reasons for this unjustified assessment and evaluation probably lie in a) the pressure from students and parents, since the grade is still the most common motive for mastering the curriculum or b) the school's aspiration for its students to achieve the best possible success. This leads to the conclusion that the final grade does not appropriately measure the mathematical competence.

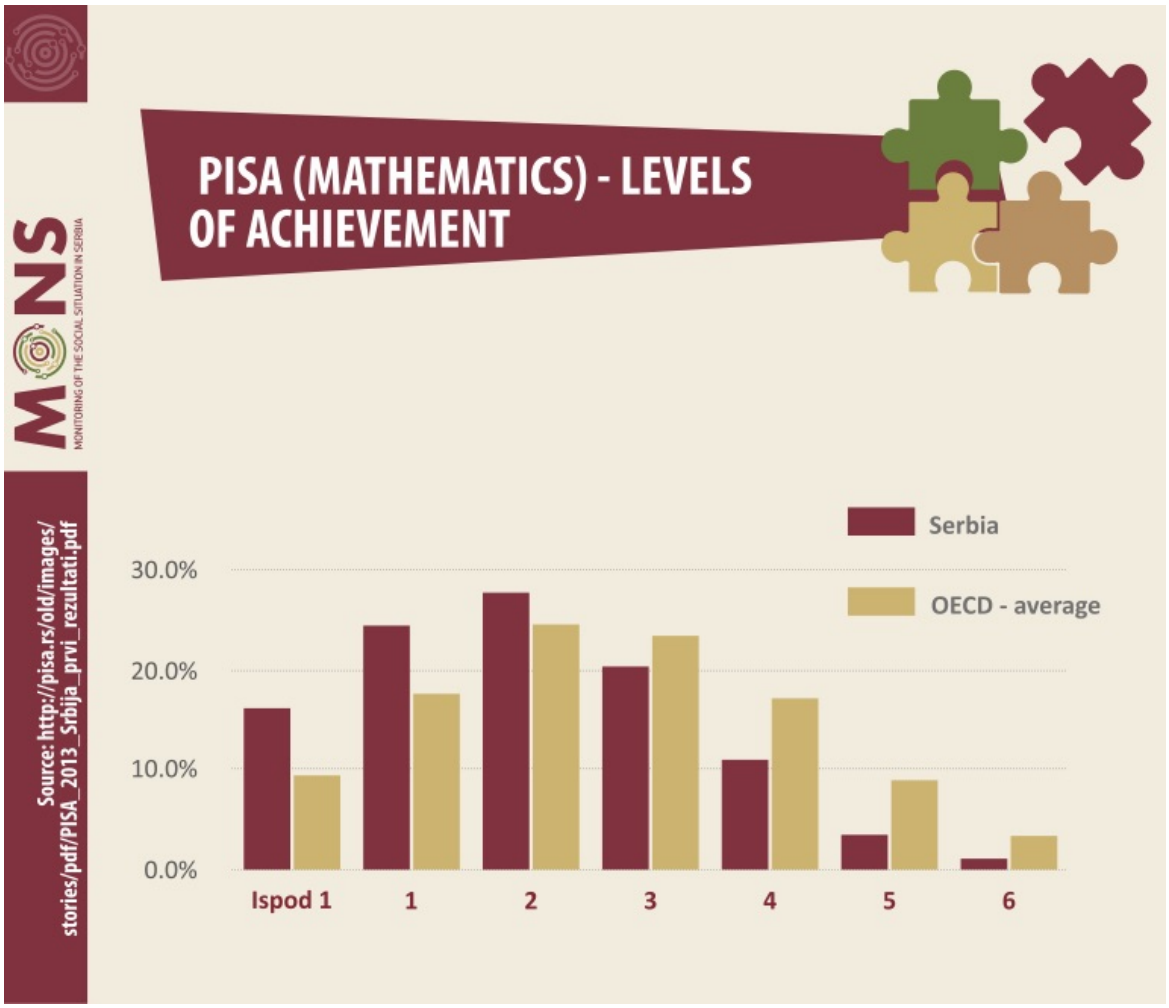


The second indicator is the success that students achieve in the *final exam* at the end of the eighth grade. The same population of students has been observed as in the example of final grades. Graphical representation of the Mathematics test results, with four advanced-level tasks, seven intermediate-level tasks and nine basic-level tasks out of a total of twenty tasks, indicates that the form of distribution has changed, tending to a uniform distribution or to a smooth, normal distribution. 18.7% of students did at least one advanced-level task. Almost half of the students, i.e. 46.3%, scored between 5 and 12 points. Regardless of the fact that the distribution of this factor is significantly different from the final grade distribution, we cannot draw the conclusion that the final exam measures mathematical competence because the instrument (i.e. the test) that the students take does not meet the requirements of the evaluation; it is actually selective in nature.



Finally, the third indicator is the success that the students from Serbia achieved in the PISA test carried out in 2012. One of the goals of this research is the assessment of the mathematical literacy of the 15-year olds. The briefest summary related to the mathematical education is summed up in the following sentence "*Almost 40% of students did not reach the level of functional literacy, which is at the same level as in 2009. In comparison to OECD countries, mathematical competence of the students from Serbia is about 45 points lower, which corresponds to the effect of one year of schooling in OECD countries*". The data obtained from this research is largely

incompatible with the two previously considered indicators. In addition to a large number of students being functionally illiterate in mathematics, extremely small number of students, only 4.6%, reached two highest levels of achievement. This distribution is now distinctively right sloped.



Based on the mentioned analysis, it is difficult to find the essential answer to the question of mathematical education in the Republic of Serbia. However, it can be concluded that it is necessary to take new reform steps in increasing the mathematical competence, since the data shows that a lot of issues that do not function. If the IT industry becomes one of the key industries in Serbia, then it is more than necessary to intensify the work on the development of the mathematical education as the prerequisite for the development of IT experts. We need to leave the never ending circle of competition, that is, to abandon the theory that the only important thing is who is better than others (which student is better than others in a class, which class is better than others in a school, which school is better than others in a city, which country is better than others in international researches). Serious engagement in mathematical education implies clearly defined goals, planning activities and measures for achieving the objectives, and finally, good instruments for monitoring the implementation of activities and measures. Unfortunately, so far we have been partially successful only in the first step, that is, in the goal setting. The lack of resources and the proper motivation

in all the elements of education (students, teachers, parents, and ministry) resulted in not progressing towards the set goals. In order to leave this never ending circle, it is necessary to:

- provide constant support for every single teacher, which implies availability of innovative activities and methods in a simple and accessible manner (as opposed to currently widespread model of professional training which very often lead to further exhaustion and demotivation of teachers);
- conduct a serious media campaign and thus at least try to mitigate

  negative attitude towards education, and in particular towards mathematics;

- provide national testing for the purpose of assessment of students'

  achievements, thus making the correct diagnosis of the educational system, and through which the control and the correction of evaluation would be introduced.

And in the end, let us remind ourselves of the words said by one of the greatest scientific minds from the beginning of the 19th century Siméon Poisson: "*Life is good for only two things, discovering mathematics and teaching mathematics*.".

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