PISA 2012 Mathematics literacy in Serbia: A multilevel analysis of students and schools

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In PISA 2012 cycle, the focus was on the mathematics literacy. Data collected in PISA survey in Serbia on 4684 respondents show that students on average have significantly lower performance compared to average OECD performance. The aim of the study was to explore student (variables at the first level) and school level predictors (variables at the second level) of the PISA mathematics literacy using multi-level modelling. The most important finding is that student and school level variables are explaining variability in PISA mathematics performance almost equally. Results show that on the student level, significant predictors are gender, noncognitive characteristics (mathematics anxiety, mathematics self-efficacy, mathematics self-concept, openness for problem-solving), student perceived teaching quality and studying habits. Results also indicate that several school-level variables have direct effects on the PISA math performance and that several school-level variables moderate the relationship between student characteristics and PISA performance.

Key words: mathematics literacy, student-and school-level factors, multilevel modelling, PISA 2012

Highlights:

- PISA 2012 focused on mathematics literacy.
- Student and school level variables equally contribute to the achievement.
- On a student level, self-beliefs have crucial importance for achievement.
- Sufficient number of math teachers and favourable disciplinary climate are important.
- Education system in Serbia should minimize between-school differences.

Academic achievement is one of the key outcomes used for the assessment of the quality and effectiveness of the education system in a country (Shin, Lee, & Kim, 2009). Identifying factors relevant for scholastic performance is of special importance considering that the economic welfare is dependent on the quality of an education system (Organisation for Economic Co-operation and Development [OECD], 2004; Rinderman, 2008; Stankov, 2009). In the recent years, research has been focused on exploring factors influencing high academic achievement, and investigating how to improve students' academic performance (Shin et al., 2009). The OECD Programme for International Student Assessment (PISA) is an internationally standardised assessment jointly developed by participating nations and administered to 15-year-old students. The PISA assesses the application of knowledge from different fields to problems within the real-life context (OECD, 2001). PISA focuses broadly on the application of knowledge and the skills students learned both in and out of the school and uses the term *literacy* to refer to the schooling outcomes. Recognising the difference between student *literacy ability* and academic achievement, the PISA was developed to assess whether 15-year-old students who are near the end of or just finish compulsory education have obtained the knowledge and skills that prepare them for the continuation of education and full participation in the society.

The PISA began in 2000 and was held every three years. In each country, the student sample in each PISA cycle typically ranges between 4,500 and 10,000 respondents. In each cycle, the subject areas of reading, mathematical and scientific literacy are covered, with one subject being selected as a focus while two other subjects are assessed more briefly. In the first PISA cycle in 2000 reading literacy was a focus. The second assessment in 2003, focused on mathematical literacy, while in 2006 scientific literacy was a dominant area of assessment. In 2009 reading was again a focus of interest and in 2012 mathematics literacy.

Scholars have been studying factors influencing academic performance, and it was found that 80% of the variance in performance could be accounted for by students' effects, 13% by teacher effects, and 7% by school effects (Marzano, 2000). Another large research synthesis by Hattie (2015) showed that about 50% of the variance in learning stems from students' characteristics, 20% to 25% of the variance are teacher effects, while the rest stems from peers, principals, and schools. A meta-analysis demonstrated that although teaching practices and school/curricula factors are influencing performance, the strongest effects arise from psychological variables of the students (see Stankov, Lee, Luo, & Hogan, 2012). Studies show that among the student variables influencing academic performance, the general cognitive ability is the most important predictor (Kuncel, Hezlett, & Ones, 2004). However, in the recent literature, a shift towards the assessment of non-cognitive variables that could influence the scholastic performance has been noticeable (see Lee &

Stankov, 2016; Stankov & Lee, 2017; Stankov et al., 2012). Scholars think that it is important to uncover important variables affecting performance on the tests, especially those which are considered as "amenable to change, sensitive to intervention, and perhaps leading to an improved academic performance" (Stankov et al., 2012, p. 747). Among relevant non-cognitive variables, scholars identify several self-belief constructs, like confidence (Stankov et al., 2012), self-efficacy, self-concept, and anxiety related to specific school subject (e.g., mathematics, language, or science) (Lee, 2009; Lee & Stankov, 2013; Stankov & Lee, 2017). Students' self-efficacy beliefs are referring to their judgements of confidence to perform some academic task or to succeed in certain academic activity (Pajares & Graham, 1999). In addition, self-efficacy beliefs are considered to mediate the relationship between some other factors influencing performance, e.g., previous experience or skills, and subsequent actions. Researchers have shown that self-efficacy beliefs are predicting mathematics performance better than math anxiety does (Pajares & Miller, 1995) and that its influence on math performance is equal as the influence of general cognitive abilities (Pajares & Kranzler, 1995).

Previous PISA findings investigating gender differences in math performance found that in most countries males outperform females, but the overall differences were not large (OECD, 2004, 2017). Despite the absence of large overall gender differences in mathematics, there are reasons to continue exploring gender differences in mathematics performance (OECD, 2004). The mere fact that gender differences in mathematics performance persist indicates that not all environments are nurturing equal opportunities, which further poses a serious challenge to achieving gender equality in science, technology, mathematics, and engineering (OECD, 2014). Another important reason is that gender differences in tertiary qualifications in mathematics and computer science remain high (OECD, 2004, 2014).

Meta-analytic study by Sirin (2005) demonstrated that students' socioeconomic status (SES) is moderately linked with academic achievement, but that several variables are moderating this relationship, i.e., the unit, the source, the range of SES variable, the type of SES–achievement measure, school level, minority status, and school location. However, numerous studies showed that the mean socioeconomic composition of the school is strongly linked with academic achievement, even more than the individual student SES across countries (McConney & Perry, 2010; OECD, 2004, 2007; Perry & McConney, 2010). Previous studies analysing the impact of the SES on educational achievement discovered that apart from direct effects of SES on educational achievement, the SES has indirect effects via non-cognitive variables, like school anxiety, which is moderating this relationship (Baucal, 2012).

Studies revealed that teacher support is among the strongest predictors of academic achievement, adjustment, social and motivational development (Sakiz,

Pape, & Hoy, 2011; Yıldırım, 2012). Studies indicated that when students perceive their teachers as supportive, they tend to be more interested in and less anxious about classroom activities (Lapointe, Legault, & Batiste, 2005; Wentzel, 1998). Moreover, perceived teacher support predicted students' interests and enjoyment positively and mathematics anxiety negatively (Ahmed, Minnaert, van der Werf, & Kuyper, 2010). However, results show that throughout the middle school students' perception of teacher support and the sense of school belonging declines (Anderman, 2003; Reddy, Rhodes, & Mulhall, 2003). When it comes to mathematics lessons, reports show that students describe mathematics as less valuable, and report a decline in effort and persistence in mathematics classes (Pajares & Graham, 1999).

Rationale for examining Serbia

Since 2003, Serbia is participating in PISA assessment. The results of PISA 2012 showed that students from Serbia on average have 449 points, which is about 45 points lower average performance compared to OECD countries. This difference corresponds roughly to the effects of 1 year of schooling (Pavlović Babić & Baucal, 2013). According to the PISA 2012 results, less than 35% of students achieve the third or higher levels of proficiency[3] (where students have not only reproducible but have knowledge transfer) (Pavlović Babić & Baucal, 2013). Moreover, less than 5% of students achieve highest levels of proficiency (ability to conceptualize, generalize and utilize information, solving complex tasks, etc.), which indicates that Serbian education system is not sufficiently supporting students with high academic potentials. As a comparison, on average across OECD countries, 13% of students are top performers in mathematics, i.e., level 5 or 6 (OECD, 2014). Furthermore, almost 40% of students have achievements below the second level of mathematics proficiency, which means that these students have not achieved the minimum level of functional literacy according to EU criteria (on average across OECD countries 23% of students did not reach the baseline level 2 in the PISA mathematics assessment, OECD, 2014). These students are at high risk of dropout, frequently are faced with difficulties in getting employed, and usually, they are working only low-paid jobs. For comparison, Europe 2020: A European strategy for smart, sustainable and inclusive growth sets a benchmark to reduce this category of students on 15% (European commision, 2010). These results suggest that the Serbian education system is not supporting students to achieve a minimum level of functional literacy or to achieve higher levels of knowledge and achievement. Studies show that country characteristics, like the gross domestic product (GDP), social inequality, and cultural values influence student achievement directly, or indirectly via family or motivation (Chiu & Xihua, 2008). The 2017 Fragile

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3   Detailed description of levels of proficiency assessed by PISA is available in OECD, 2014.

State Index (FSI) statistics[4] for Serbia indicate that several of FSI indices which are highly related to the quality of education and serious differences between the regions of the country, like professional flight and brain drain, economic decline, and economic inequality, are pointing worrying level of decline or lack of progress (FSI, 2017). Considering findings obtained as part of FSI statistics is of special importance since education represents social service sector in which impact of the state fragility is significant, e.g., access and quality of provision for children, working conditions for teachers, good governance, etc. (Kirk, 2007). Education should be a crucial part of the fragility analysis since it represents both the cause and possible solution for the economic, social, and political growth of a country.

Some studies indicate that at least one part of this relatively low performance of Serbian students can be attributed to the "grade effect", i.e., the fact that in most of the participating countries students taking PISA test are in grades 9 and 10, while in Serbia students are grade 9. The effect of this one extra year of schooling is associated with approximately 59 points (Baucal, Pavlović Babić, & Willms, 2006). In spite of the "grade effect" influencing performance, we should also focus and investigate the factors stemming from the social environment and the students themselves. It is plausible that the relationship between student and school factors on one side, and the achievement on PISA on the other side varies across countries (McConney & Perry, 2010). Results of previous studies show that cultural differences in education systems may explain to certain extent achievements among different countries and that one should consider these potential sources (Shin et al., 2009). So far, the relevance of non-cognitive and contextual factors on PISA achievement in Serbia was not explored to sufficient extent. Having in mind previously mentioned strong link between education quality and the welfare of the country (e.g., Chiu & Xihua, 2008; Fragile State Index, 2017; Kirk, 2007), it is important to investigate what are the crucial factors predicting high achievements so that improvement in the Serbian education system could be potentially made. The goal of the present study is to investigate the relationship between student factors, and PISA mathematics literacy, and to investigate the extent to which school factors are moderating these relationships. Mathematics is among the topics most frequently investigated in the educational context. Studies showed that mathematics is related to less interest and enjoyment and higher levels of anxiety among students than other domains in the curriculum

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4 The FSI is a sum of ratings over 12 objective indicators of the social, economic, and political welfare of the country. The lower the FSI, the lower the risk for the country to be in a fragile state (The Fund for Peace, http://ffp.statesindex.org/). Compared to 2016 when Serbia was ranked 98th (out of 178 countries), in 2017 rank was 107. However, when trends in changes of the indices are inspected, it is noticeable that there is a fluctuation from one year to another, and that economic and social indices did not make significant progress or are even worse in 2017.

(OECD, 2010; Radišić, Videnović, & Baucal, 2015). Furthermore, the number of studies employing multilevel modelling in exploring the simultaneous influence of several non-cognitive and contextual factors in predicting mathematics literacy is low, and this number is even lower when it comes to exploration of Serbian data (Radišić et al., 2015; Teodorović, 2012). Having this in mind, it is important to determine which factors are influencing PISA math performance in Serbia, so that adequate educational policies could be developed.

Method

Sample

The data used to investigate factors influencing student achievement in mathematics were collected as part of OECD Programme for International Student Assessment – PISA 2012 testing cycle in Serbia. In each PISA cycle, a student sample is drawn in two steps. First, a sample of schools is selected from a total list of schools controlling for the student population of interest. PISA is an age-based survey, i.e., 15 years old students are eligible to take part in the study. In most participating countries these students are approaching the end of compulsory schooling. In Serbia, 15-year-old students are going to upper secondary school (grammar schools and types of vocational schools). The sample of school is stratified according to geographical regions, and types of upper secondary schools. Then, a simple random sample of 35 students from each school is drawn. If the school has less than thirty-five 15-year-old students, then all students are invited to participate in the survey. In total, sample on student level consisted of 4684 respondents (50.6% female, average age 15.86 years, $SD = 0.28$), while on the school level there were 142 cases.

Instruments

The PISA 2012 survey focused on mathematics, with science, problem-solving skills, and reading as minor topics of assessment. The PISA 2012 assessment was conducted using paper-and-pencil tests, and in some countries, the computer-based assessment was employed in addition to paper-and-pencil test. The question format varied – on some of the test items, respondents had to provide a simple answer, while on some other items, respondents were asked to generate their own responses. In addition to the tasks mapping achievement in a specific domain, data were collected using Students' Questionnaire (investigating student-level factors influencing performance), and School Questionnaire (investigating school-level factors influencing performance). These items are targeting contextual information, i.e., a wider spectrum of student and school characteristics that could be of relevance for school performance.

Analytic strategy

Based on the results of previous studies investigating student achievement on PISA (Demir, Kılıç, & Ünal, 2010; Konishi, Hymel, Zumbo, & Li, 2010; Lee & Stankov, 2013; Stankov, 2013; Stankov et al., 2012), variables assumed to have an impact on mathematical literacy were extracted from the student and school data set. Then, the regression analyses

were used to indicate possible predictors of mathematics performance. In the second step of the analyses, based on these preliminary findings, multilevel modelling using Hierarchical Linear Modeling (HLM) software (HLM-6; Raudenbush, Bryk, & Congdon, 2004) was done.

Multilevel modelling is a regression-based analysis appropriate for research designs where data are organised hierarchically, at more than one level (Anderson, Milford, & Ross, 2009). It is appropriate analytic method because it deals efficiently with the issue of the ecological fallacy (which is an assumption that empirical relations observed at the group level generalize to the individuals at the individual level and vice versa) because it simultaneously estimates effects on both levels (May, Boe, & Boruch, 2003; Nezlek, 2008). In this study, the units of the analysis at a lower level are students who are nested within aggregate units at a higher level, i.e., schools. On the selected variables, the two-level model was specified, i.e., the student (level 1), and the school level (level 2).

Due to the PISA 2012 rotation design of the booklets, all questions from Student Questionnaire were not administered to all students. Since multilevel analysis does not tolerate missing data, missing data had to be replaced. For missing data analysis, NORM software (Graham, 2012) was used. The algorithm used for missing values imputation was EM (Expectation and Maximization algorithm, ML mode). EM (ML mode) converged in 107 iterations. A complete dataset with imputed data was used in the subsequent analyses.

Variables

A student-level linear regression model was used to examine the predictive value of chosen students' characteristics on PISA mathematics performance. As a criterion variable, PISA average score in mathematics was used. Several variables were identified as potentially relevant at the student-level for the outcome variable: gender, SES, non-cognitive variables, students' perception of disciplinary climate, repetition of the grade, and students' perception of teacher support. In PISA, index of socioeconomic status is derived from five indices: highest parental occupation, highest parental education expressed in years of education, economic status, cultural possessions, and educational resources at home. Several variables operationalizing self-beliefs were found to be relevant: mathematics anxiety, mathematics self-efficacy, mathematics self-concept, and openness for problem-solving (Stankov, 2013). All self-belief variables are composites. *Mathematics anxiety* depicts whether a student worries about the achievement, and to what extent student feels uncomfortable while doing mathematics. *Mathematics self-concept* refers to the extent to which students are feeling competent in the mathematics. *Mathematics self-efficacy* is students' perception of the ability to solve mathematical problems. *Openness for problem-solving* refers to intellectual curiosity of the student for different contents and complex problems, ease of processing information and connecting different contents. In addition, we have included data on *students' motivation and behaviours related to learning mathematics*, like mathematics interests and enjoyment in mathematics, the extent to which student enjoys practising mathematics, attitudes of the students toward mathematics, and the time student dedicates to studying. Moreover, *students' perception of disciplinary climate* on math classes, whether *student repeated a grade*, and *students' perception of teacher support* in learning mathematics were used as predictors. Preliminary regression analyses indicated which variables met the criteria in the regression equation and those were included in the level-1 (Table 1).

Table 1

Student and school-level variables extracted for two-level hierarchical linear modelling

Student-level variables	
Variable	Description
	Motivational and noncognitive aspects of mastering mathematics
Mathematics anxiety (ANXMAT)	Sample item: "I get very nervous doing mathematics problems"
Mathematics Interest (INTMAT)	Sample item: "I enjoy reading about mathematics"
Mathematics self-efficacy (MATHEFF)	Sample item: "Understanding graphs presented in newspapers"
Mathematics Self-Concept (SCMAT)	Sample item: "I am just not good at mathematics"
Openness for problem-solving (OPENPS)	Sample item: "I can handle a lot of information"
	Student perceived teaching quality
Teacher support (TEACHSUP)	Sample item: "The teacher shows an interest in every student's learning"
Disciplinary climate (DISCLIMA)	Sample item: "Students don't start working for a long time after the lesson begins"
	Studying habits
Learning time in mathematics (MMINS)	Average time per week on mathematics
Grade repetition (REPEAT)	
School-level variables	
School size (SCHSIZE)	The total enrollment at school based on the enrollment data provided by the school principal.
Teacher Participation in Leadership (LEADTCH)	Sample item: "I provide staff with opportunities to participate in school decision-making"
Mathematics extension courses offered at school (MATHEXC1)	Mathematics extension classes offered at school (extension courses without differentiation based on prior achievement or either remedial or enrichment)
Mathematics extension courses offered at school (MATHEXC2)	Mathematics extension classes offered at school (both remedial and enrichment)
The proportion of mathematics teachers (PROPMATH)	The number of mathematics teachers divided by the total number of teachers.
The student-teacher ratio (STRATIO)	The number of enrolled students divided by the total number of teachers.
Teacher shortage (TCSHORT)	Sample item: "Lack of qualified mathematics teachers"
Student-related factors affecting the school climate (STUDCLIM)	Sample item: "To what extent is the learning of students hindered by: Disruption of classes by students"

Following the recommendations of Nezlek (2008) on how to build multilevel models, preliminary analyses were conducted to inspect which predictors at the student level are relevant for mathematics performance. The forward-stepping procedure was applied in the construction of level-1 models.

Level-1 Model equation:

Y = B0 + B1*(GENDER) + B2*(ANXMAT) + B3*(DISCLIMA) + B4*(INTMAT) + B5*(MATHEFF) + B6*(MMINS) + B7*(OPENPS) + B8*(REPEAT) + B9*(SCMAT) + B10*(TEACHSUP) + R

A school-level regression model estimated the association of school characteristics with math performance, and this was the level-2 equation. Two-level models were built using the forward-stepping procedure. Variables found to be of relevance for the performance at the school level are *school size* and non-material *school resources*, e.g., the number of teachers in the school, student-teacher ratio, the proportion of certified math teachers. In addition, *school climate* (the factors at the student level influencing school climate) and *school leadership* (teacher autonomy in making important decisions, solving problems and conflicts, and the extent to which the school manager coordinates curricula, educational goals, and education of teaching staff), and school activities related to math classes[5] (mathematics extension courses) were also included in the analyses. School-level variables used in the multilevel modelling analyses are presented in Table 1. The level-2 Model equation is provided in Supplementary materials (https://osf.io/d8b7y/).

Results

Baseline model

The unconditional model was tested, and it showed that 55% of the variance account for within the school variance, while 45% of the variance was explained by the between-school variance. The fixed effect for the intercept was 443.84 (*SE* = 5.13), which suggests that the mathematics literacy is almost equally dependent on the individual differences and the system. As it is unusual result in the light of what has been usually obtained (Marzano, 2000) to find out which of these contextual factors make the difference is of ultimate importance. The analysis showed that extracted school-level variables (all of them simultaneously) explain 25% of the variance between schools (the effect of math teacher shortage and school climate being the strongest contributors to the linear composite, followed by teacher shortage and school size). When variables were entered successively one-by-one proportion of math teachers explains 12% of the variance between schools while student-related factors affecting school climate, 7% of the variance.

Level-1 models

Level-1 models were built using forward-stepping procedure (Nezlek, 2008). Results of the level-1 model analyses are displayed in Table 2. Our

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5   Variable Mathematics extension courses offered at school (MATHEXC) originally had three different categories based on the extension course types offered at school: 1) additional mathematics courses without differentiation based on prior achievement; 2) school offering either enrichment or remedial classes; and 3) schools offering both enrichment and remedial classes. MATHEXC was recoded into two binary variables MATHEXC1 (0 – additional courses without differentiation and 1 – either remedial or enrichment classes) and MATHEXC2 (0 – either remedial or enrichment classes, and 1 – both remedial and enrichment classes). Original variable had to be transformed prior to using it in the analysis into two binary variables so that imputation of missing values could be done.

analyses demonstrated that boys have significantly higher performance in mathematics than girls. On average, boys score 18 points higher than girls on PISA test. In addition, those students who score higher on mathematics self-efficacy, mathematics self-concept, and openness for problem-solving, have higher performance. Moreover, lower levels of mathematics anxiety lead to higher mathematics literacy.

The students who perceive disciplinary climate in the schools as more favourable have higher PISA achievements. Our results also show that when students perceive that teachers are providing higher support average achievements are lower. Interestingly, results show that students who claim to enjoy reading about mathematics, and doing tasks, score lower on PISA.

Students who spent more time studying mathematics per week have higher performance. One of the most significant negative predictors is a repetition of the grade, where losing one school year leads to the achievement lower for 51 points (which corresponds to the effects of more than 1 year of schooling in OECD countries (Pavlović Babić & Baucal, 2013). Although the overall number of students repeating a grade in Serbian sample is relatively small (about 1%), this result can be considered as very worrying having in mind that Serbian students on average are already lagging behind OECD countries one school year on PISA. An interesting finding is that socio-economic status of the students when observed in the context of other predictors, loses its predictive strength.

Level-2 models

When two-level HLM was performed, results showed that direct positive effects on the achievement had school size, the proportion of the certified math teachers, student-related factors affecting school climate, while the shortage of teaching staff in the school had a negative effect. Results are provided in Table 2.

Table 2

Final estimation of fixed and interaction effects: two-level HLM model – outcome variable mathematics achievement (Math-Achievement)

Fixed effects on Math-Achievement	Coefficients	SE	t ratio	p value
Level 1/Student level effects				
Intercept (B0)	443.68	5.13	86.43	.000
Gender (B1)	17.62	2.24	7.86	.000
AnxMat (B2)	-9.67	1.25	-7.73	.000
Disclima (B3)	7.11	1.12	6.34	.000
IntMat (B4)	-10.30	1.44	-7.14	.000
Matheff (B5)	20.36	1.23	16.57	.000
>> by Mathexc2 on MathEff	-6.95	2.62	-2.65	.009
MMins (B6)	0.12	0.03	4.24	.000
>> by Mathexc1 on MMins	-0.20	0.09	-2.37	.019
>> by Mathexc2 on MMins	-0.18	0.06	-3.08	.003
>> by Studclim on MMins	-0.12	0.04	-3.44	.001
OpenPS (B7)	4.47	1.00	4.46	.000
Repeat (B8)	-50.81	11.78	-4.31	.000
>> by SchSize on Repeat	-0.11	0.04	-2.82	.006
>> by LeadTch on Repeat	33.98	13.52	2.51	.013
>> by StudClim on Repeat	-69.41	18.14	-3.83	.000
ScMat (B9)	14.05	1.46	9.61	.000
>> by SchSize on ScMat	-0.01	0.01	-2.49	.014
>> by STRatio on ScMat	1.18	0.55	2.15	.033
TeachSup (B10)	-10.53	1.07	-9.82	.000
>> by SchSize on TeachSup	0.01	0.00	3.39	.001
>> by PropMath on TeachSup	144.47	40.76	3.54	.001
>> by StRatio on TeachSup	-1.24	0.38	-3.28	.002
>> by StudClim on TeachSup	3.62	1.34	2.70	.008
Level 2/School-level effects				
Intercept (G00)	370.88	18.13	20.46	.000
SchSize (G01)	0.04	0.01	2.71	.008
LeadTch (G02)	-6.32	5.24	-1.21	.230
Mathexc1 (G03)	-19.98	14.19	-1.41	.162
Mathexc2 (G04)	4.62	9.33	0.50	.621
PropMath (G05)	569.52	169.73	3.36	.001
STRatio (06)	-0.43	1.60	-0.27	.790
TcShort (G07)	-18.24	7.49	-2.44	.016
StudClim (G08)	18.39	5.81	3.17	.002

Note. AnxMat – mathematics anxiety; Disclima – disciplinary climate; IntMat – mathematics interests; Matheff – mathematics efficacy; MMins – average time per week on mathematics; OpenPS – openness for problem solving; Repeat – grade repetition; ScMat – mathematics self-concept; TeachSup – teacher support; SchSize – school size; LeadTch – teacher participation in leadership; Mathexc1 – mathematics extension classes offered at school (either remedial or enrichment) MathExc2 – mathematics extension classes offered at school (both remedial and enrichment); PropMath – the proportion of mathematics teachers; STRatio – student-teacher ratio; TcSchort – shortage of teaching staff; StudClim – Student-related Factors Affecting School Climate.
>> Interaction effect.

Mathematics efficacy was negatively moderated with the offer of both remedial and enrichment classes. Positive effects of the mathematics self-concept on the achievement are boosted when the student-teacher ratio is more favourable, and when the students are going to larger schools. The relationship between the average time spent in learning mathematics during the week and the achievement was negatively moderated with mathematics extension courses at the school, which means that if the students are offered with only remedial or both remedial and enrichment classes the positive effects of the longer time invested in studying is diminished. In addition, average time spent during the week and the achievement was negatively moderated by student-related factors affecting school climate. When it comes to the negative effects of grade repeating on the achievement, these effects are reduced when the school is of smaller size, and if the student-related factors to the climate are positive. However, negative effects of grade repeating are enlarged when the teacher participation in leadership in the school is higher.

Negative effects of teacher support on the student achievement were moderated with several variables. These effects were reduced when the student-teacher ratio was more favourable. However, in larger schools, where the number of the certified math teachers was higher, the student-teacher ratio is more favourable, and where student-related factors of the climate were perceived as better, negative effects were stronger.

Overall, level-2 variables did not moderate the relationship between the non-cognitive factors (mathematics anxiety, openness for problem-solving) and mathematics performance. Also, they did not moderate the relationship between interest in and enjoyment of mathematics and performance, and favourable disciplinary climate and performance in mathematics. Complete output of two-level modelling is provided in Supplementary material (https://osf.io/d8b7y/).

Discussion

This study was focusing on personal and contextual factors influencing performance on PISA math test. On average, Serbian students have significantly lower achievements compared to the OECD countries, i.e., achievement corresponding approximately to the effects of one year of schooling. The most important result is the fact that contextual, i.e., school-related factors predict math performance almost as strongly as personal characteristics of the students. This result is in line with the findings from other middle-income countries (Lockheed, Prokic-Breuer, & Shadrova, 2015). However, it means that contextual factors explain 25% more variance in math performance in comparison to what has been usually obtained (Marzano, 2000; Stankov et al., 2012). This finding indicates that the level to which students' achievement is dependent on contextual factors is worrying and that education system should strive more towards equalizing the differences between schools and to improve the work conditions and the teaching quality. Results suggested the fundamental importance of the number of qualified math teaching staff on the PISA performance. This finding is in line with previous studies indicating that subject-specific knowledge is relevant for high-quality teaching and student learning (Baumert et al., 2010). In addition,

it seems that those schools whose students are more successful in mathematics, and the ones nurturing good disciplinary climate.

Our results are demonstrating that male students are performing better in mathematics. This result is consistent with the previous meta-analytic findings (Hyde, Fennema, & Lamon, 1990; Lockheed et al., 2015) showing that in high-schools, males outperform girls in mathematics, and with findings obtained in previous PISA analyses (OECD, 2004). Having in mind results of a meta-analytic study (Else-Quest, Hyde, & Linn, 2010) indicating that gender differences in math performance are resulting from lower self-beliefs of girls, school system and teachers should be directed to provide girls with encouragement, adequate educational tools, and visible female role models who excel in mathematics.

Our results speak in favour of the importance of self-belief constructs for scholastic achievement. That said, higher self-efficacy, higher self-concept, lower levels of mathematics anxiety, and higher openness for problem-solving, are highly important for achieving higher levels of mathematics PISA proficiency. These results are consistent with previous findings demonstrating that self-beliefs constructs are among the most important predictors of scholastic achievement (Stankov, 2013; Stankov & Lee, 2014; Stankov, Morony, & Lee, 2014).

Overall, our analyses demonstrated that school-level variables are not moderating influence of self-beliefs on performance. The only exception was that having and participating in mathematics extension courses (both remedial and enrichment) reduces the positive effects of the beliefs in one's own efficiency on the performance. It is possible that if students are participating in extension courses, student's self– perceptions are getting calibrated and more resemble the real competencies and abilities. The degree to which judgements of one's competence are accurately reflecting actual performance is named "calibration of self-concept" (Bol, Hacker, O'Shea, & Allen, 2005). Self-assessment is a demanding cognitive task, and often students tend to inaccurately calibrate their self-perceptions and to overestimate or underestimate their competence. Inaccurate calibration can be a consequence of information deficit, misinterpreted feedback from the others, neglect of relevant information, or incomplete perception of competence (Dunning, Heath, & Suls, 2004). When it comes to mathematics self-concept, our analyses showed that school size and the student-teacher ratio can moderate its relationship with the performance. Namely, if the school is smaller and the student-teacher ratio is more favourable, the impact of positive self-concept on performance would be reinforced. This result is in line with some previous findings indicating that smaller school facilitate higher achievement and that this can be related to the increase in academic self-concept (Lee & Loeb, 2000; Leithwood & Jantzi, 2009).

Unexpectedly, our analyses showed that higher mathematics interests and enjoyment in mathematics are related to somewhat lower PISA performance. Some studies suggest that it is still an open question whether academic interests really enhance learning and achievement under the restrictions of everyday school life (Köller, Baumert, & Schnabel, 2001). Namely, previous findings showed that in school systems in which knowledge acquisition is a consequence of highly structured instructions (which applies to Serbian schooling system), particularly

in lower secondary school usually corresponding to eighth to tenth grade, higher interests are not predicting higher achievements on PISA math test, but that it becomes important predictor in upper secondary school (Köller et al., 2001).

When it comes to the relationship between SES and academic attainment, previous studies indicated that it may vary significantly between countries (Pokropek, Borgonovi, & Jakubowski, 2015). As shown in a meta-analytic study by Sirin (2005) SES has a moderate relationship with academic achievement in the United States, but the strength of this relationship showed a decrease over time. In addition, a study by Heyneman and Loxley (1983) showed that, in developing countries, family characteristics and SES play a smaller role in academic achievement compared to the school and teacher quality. Our results are consistent with these findings and show that in Serbia SES of the students is not a significant predictor of the achievement. Despite the zero-order significant correlation with the criterion variable, when placed in the model along with the other student-level variables, SES loses its predictive power. This finding might be interpreted as the indicator that Serbian education system offers fairness and equity at least to a certain extent. However, our results are not indicating that future studies should not continue to investigate the role of SES in academic achievement and/or PISA achievement since findings on the family effects and SES as its important component are not unanimous.

One of the findings that need future investigation is that students' perception of teacher support is negatively predicting mathematics achievement. This result may indicate that high-school teachers in Serbia are more supportive for students who have difficulties in studying, than for the ones who have higher achievements. On one side, this result can be considered as positive if observed from the perspective of fairness. On the other side, we cannot rule out the possibility that this indicates that better students are not supported to a sufficient extent in the learning process. Importantly, in larger schools with higher number of certified math teachers, if the student climate in the school is more favourable, when students are disciplined, respect the teachers and each other, and behave well in the school, this negative effect of perceived teacher support on mathematics achievement tend to be weakened to some extent. The same relations can be also described the following way: if the student climate in the school is bad, if students are undisciplined, if they do not respect their teachers and each other, the deleterious effects of the increased teachers' support on achievement are pronounced. Our results are in line with previous studies showing that students need to feel that teachers care about them, but also need to have a clear sense of the structure, need to know what adults expect of them regarding the conduct, and what are the consequences resulting from not meeting expectations regarding conduct (Klem & Connell, 2004). Furthermore, our findings indicate that relationship between perceived teacher support and achievement is negatively moderated by more favourable student-teacher ratio. To conclude, this study showed that higher perceived teacher support is not a condition that improves math performance. It is important to further investigate the complex meaning of this variable and to figure out precisely which aspects of teacher support carry these undesirable

influences on the mathematical achievement, especially when they are coupled with unfavourable student climate in a school.

The disciplinary climate in the classroom was positively related with achievement, and this is in line with previous findings showing that in schools where the disciplinary climate is strong, the students have higher achievements (OECD, 2004; Shin et al., 2009). Some findings obtained in previous studies show that when schools are more oriented toward stricter disciplinary climate with the more authoritative organization have higher mathematics achievements (see Shin et al., 2009).

Previous findings showed that students in different countries vary substantially in the average time they dedicate to studying at home (Fan, Xu, Cai, He, & Fan, 2017; Trautwein, 2007). Overall, authors agree that the higher the average time dedicated to studying and homework, the higher is the achievement (Fan et al., 2017; Trautwein, 2007), and our results are in line with these findings. However, our results indicated that if students are engaged in mathematics extension classes, positive effects of the long-time studying at home are diminished. It could be that participation in extension classes enables more efficient learning than learning at home and that the increasing the time spent in learning at home on the account of attending the extension classes diminishes the achievement. In other words, the more time is spent in learning mathematics the better, but it is even better if this time is spent on efficient learning, i.e., learning supervised by the teacher. Furthermore, our results show that students learn more effectively at school and they spend less time at home to study when classroom climate stemming from student-related factors is more favourable.

Our results demonstrated that repeating grade has a detrimental influence on scholastic achievement and that these students have low chances to match other peers in mathematics. If the teachers are more independent and have higher autonomy in decision-making than the negative effects of grade repetition are even more pronounced. It could be that in the school where principals are not managing the school in an appropriate manner, i.e., teachers' evaluation of students' work and their decisions on who should repeat the grade are not reassessed by the teachers' council and the principal, achievement further deteriorates. These negative effects of grade repetition are, however, reduced when the school is smaller, and the school climate is more favourable. Therefore, it seems that when the climate is favourable in the classroom and in the school, students with very low scholastic performance have better chances to compensate for losing school year.

Conclusions and implications for policy and teaching practice

Results of this study indicate that special attention should be paid to the fact that in Serbia both students' and contextual characteristics influence mathematics performance on PISA2012 to an almost equal extent. Our results indicate the extremely high influence of the school characteristics, like the proportion of certified math teachers, student-related climate and teacher shortage on students' PISA achievement in Serbia. This is one of the major issues that need to be explored in future studies.

Based on our results, 25% of the between-school variance is explained by some of the contextual factors, but future studies should try to investigate what is causing 75% of variability between schools. One of the possible directions would be to conduct three-level modelling with the region to which the school belongs added as the third level in the analyses. It is reasonable to assume that significant amount of the unexplained between-school variability stems from substantial regional differences in Serbia, as economic FSI indices suggest.

Bearing in mind the importance of non-cognitive characteristics (self-efficacy, self-concept, openness to problem-solving, and anxiety) for mathematics literacy, support of the development of student personality characteristics should be further strengthened through additional teachers training for acquiring competencies relevant for this support. In addition to supporting students who have difficulty in mastering the curriculum, teachers should pay more attention to students with the higher achievements. The results in Serbia show that the number of students with the highest achievements in mathematics is lower than in the OECD countries. Therefore, it would be important to strive for a balance between the requirements for greater achievement in mathematics and the focus on individual educational needs of the students in this field.

Overall, the number of students repeating a grade in the Serbian sample is not high. However, our results indicate that if a student repeats a grade, negative consequences are detrimental. In such a case, students repeating the grade should be placed in a class where student climate is more favourable, where they will be accepted and stimulated to give their maximum. In addition, our results indicate that in such a case, students who repeat a grade need more structured organization and school leadership.

Based on the results, one of the most important take-home messages should be that Serbian education system should strive towards employing a sufficient number of highly qualified mathematics teachers. In addition, the system should nurture favourable disciplinary climate in the schools since environment where students and teachers are respecting each other, and school rules are obeyed is stimulating for higher scholastic achievement. One of the important findings from this study implies that the ratio of the number of teachers and students should be more favourable and that the number of certified mathematics teachers in the schools should be higher.

Even though Serbian educational system is characterised by equity to a certain extent, it is of fundamental importance to continue supporting the principles of justice. The educational system should favour fairness (i.e., educational potential is not obstructed by students' gender, socio-economic status or ethnic origin) and inclusion (i.e., educational system is offering a basic minimum standard of education for all).

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PISA 2012 matematička pismenost u Srbiji: hijerarhijsko modelovanje na nivou učenika i škola

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U ciklusu istraživanja PISA 2012 fokus je bio na matematičkoj pismenosti. Podaci prikupljeni u PISA istraživanju u Srbiji na 4684 ispitanika pokazuju da učenici u proseku imaju značajno niže postignuće u odnosu na prosečno postignuće zemalja koje pripadaju OECD. Cilj istraživanja je bio da se istraže prediktori matematičke pismenosti na nivou učenika (varijable prvog reda) i škole (varijable drugog reda) korišćenjem hijerarhijskog modelovanja. Najvažniji rezultat se odnosi na to da varijable na nivou učenika i na nivou škole približno jednako objašnjavaju varijabilnost PISA matematičkog postignuća. Rezultati pokazuju da se od varijabli na nivou učenika kao značajni prediktori izdvajaju pol, nekognitivne karakteristike (matematička anksioznost, matematička samoefikasnost, matematički self-koncept i otvorenost za rešavanje problema), način na koji učenici opažaju kvalitet nastave i navike u učenju. Rezultati ukazuju i da više varijabli na nivou škole ima direktne efekte na PISA matematičko postignuće i da nekoliko varijabli na nivou škole moderira odnos između karakteristika učenika i PISA postignuća.

Ključne reči: matematička pismenost, faktori na nivou učenika i na nivou škole, hijerarhijsko modelovanje, PISA 2012