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Math anxiety—contributing school and individual level factors

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Abstract PISA 2003 survey data indicate high levels of mathematics anxiety among students in Serbia. More than a half of Serbian students are concerned with whether they will have difficulties in a mathematics class or earn poor marks. At the same time, the achievement on the mathematical literacy scale is very poor. Building on control-value theory, the analysis in this paper focuses on exploring possible correlates of math anxiety, separating the school level factors from individual level factors (HLM), and differences between different groups of students in respect to their relationship towards mathematics (hierarchical cluster analysis). Data suggest high levels of anxiety within the Serbian student body to be a rather systemic problem not contributed to a particular school. Approximately 6 % of the total variance in math anxiety is explained by the between schools differences, while 94 % of differences accounts for the within the school variance. The achievement and interest in mathematics, high mathematics self-concept, and school and classroom atmosphere are associated with a lower level of math anxiety. The only school level factor that has a minor, but significant effect is the index of economic, social, and cultural status. Based on students' attitudes towards mathematics, they can be divided into three clusters. Dimensions that distinguish the clusters are interest in mathematics and presence of math anxiety. The group displaying anxiety, scores the lowest among the three in math achievement.

Keywords Mathematics anxiety · School factors · PISA · HLM · Two level analyses

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Introduction

Teachers and students spend many hours together within the classroom walls. Apart from being a place for learning and teaching, classrooms are also arenas for the rich array of social encounters, bringing about many important personal goals. Thus, they are also places of high subjective importance saturated by strong emotional experiences which may direct relations, affect learning and classroom routines, and influence personal growth of everyone involved (Boekaerts et al. 1999; Macher et al 2012; Malmivuori 2006; Pekrun et al. 2002; Schutz and DeCuir 2002). Nonetheless, the importance of emotional experiences in the classroom setting has somehow been neglected (Zeidner 1998). As noted by Pekrun et al. (2007), research on emotions in education is in a state of fragmentation, thus limiting its theoretical and empirical progress. Nevertheless, Macher et al. (2012) noted that mathematics and test anxiety were among those topics that were more frequently investigated (e.g., Ashcraft 2002; Hembree 1988, 1990; Ma 1999; Wigfield and Meece 1988; Zeidner 1998, 2007). Furthermore, mathematics has also been shown to be related with less interest and enjoyment than other domains, eliciting most anxiety among students. The issue has been further documented by the Programme for International Student Assessment-PISA (OECD, 2010) pointing to the general lack of enjoyment in mathematics. While some studies report that boys and girls differ in the extent to which they experience positive feelings of enjoyment and pride in math (Frenzel et al. 2007), others show long-term consequences. Thus, for example, Jackson and Leffingwell (1999) noted that if a student has had bad experiences during schooling, math anxiety will continue to reappear later in life. Furthermore, while students' cognitive competencies do predict confidence in learning, affective variables better predict whether or not the student will enroll in courses or follow a career in a given domain (Ashcraft 2002; Frenzel et al. 2007; Harackicwitz et al. 2000; Wigfield et al. 2002).

The focus of this study will be on the math anxiety taking into account individual and contextual correlates of anxiety at the school level, as well as the extent math anxiety differentiates students in their relation towards mathematics as a school subject. Authors assume the existence of different groups of students considering their interest in mathematics and related anxiety. Furthermore, it is postulated that anxiety influences the achievement of these groups differently.

Theoretical framework and previous studies

When a construct of anxiety is discussed, the distinction between trait and state anxiety is emphasized (Spielberger and Sydeman 1994; Zeidner 1998, 2007). The former is perceived as a relatively stable aspect of personality related to the tendency to perceive stimuli and situations as intimidating. The latter may manifest itself as an interruption of an individual's emotional state, meaning a person will feel pressure, tension, and worry or might find himself (herself) in a state of restlessness, overly reacting to the specific situation. Mathematics-related anxiety (hereinafter math anxiety) is defined as a state in which a student *experiences negative reactions when he/she encounters mathematical concepts or procedures during their math evaluation* (Richardson and Woolfolk 1980; Cates and Rhymer 2003). This is a multidimensional construct encompassing (a) *the feeling of pressure, inadequacy, and unease while solving math problems which involve number manipulation both in academia and everyday life context,* and (b) *the feeling of pressure and unease when one's mathematical competence is being evaluated.*[1] The concept is most often operationalized through scales measuring:

[1] For details please see Bai et al. 2009; Hembree 1990; Kazelskis 1998; Krinzinger et al. 2009; Meece et al. 1990; Newstead 1998; Wigfield and Meece 1988.

concerns about school marks, feelings of helplessness, or/and nervousness in solving math problem (Bai et al. 2009; Kesici and Erdogan 2010; Zeidner 1998, 2007).

Within the social-cognitive control-value theory, the anxiety is viewed as one of the main achievement-related emotions, whereas control- and value-related appraisals are assumed to be key antecedents of students' emotional experiences in the classroom (Pekrun 2000).[2] The theory postulates appraisals relating to achievement activities, and their outcomes are of primary importance for the initiation of achievement emotions. Furthermore, control-related appraisals (e.g., competence beliefs, causal expectations, and causal attributions) and value appraisals are held to be the most important. The achievement emotions are defined as emotions tangled directly to achievement activities or achievement outcomes and are grouped into four basic categories: positive activating emotions (enjoyment, hope, and pride), positive deactivating emotions, (relief and relaxation), negative activating emotions (anger, *anxiety*, and shame), and negative deactivating emotions (boredom or hopelessness) (Pekrun et al. 2007).

Pekrun and his colleagues emphasize that students' academic histories form their academic emotions and appraisals and that the processes itself are not independent of the domain of study (e.g., mathematics) and the classroom context. Goetz et al. (2006) showed specifically how emotional experiences are organized in a domain-specific way, which is in line with some previous findings reported on domain specificity of ability self-concept, self-efficacy, causal attributions, value judgments, and goal orientations. Building on self-efficacy theory, Pekrun (2000) reported high correlations among self-efficacy in mathematics and anxiety (−0.63).

The control-value theory generally predicts that high competence beliefs will be associated with more positive emotions (e.g., enjoyment), while the belief that one is incompetent will be related to the negative emotions, such as anxiety. Thus, for example, pride will result from a combination of favorable judgments of competence and high achievement values, while anxiety should result from low competence beliefs, combined with high values of achievement (Hembree 1988; Pekrun et al. 2007). Meece et al. (1990) reported math anxiety to be in a direct negative connection with students' perceptions of their abilities in the domain and their aspirations in achievement. The existence of high math anxiety, negative perception of own abilities, and low level of expectations is negatively correlated with the math achievement. Similarly Kesici and Erdogan (2010) report higher anxiety levels among the students aiming at higher math achievement, as well as among the students experiencing low self-confidence. Boekaerts (2007) reports students with initial sense of competence in mathematics experience numerous positive and little negative emotions during mathematics homework. She argues that the pattern of positive and negative affects influence their self-assessment of completed homework and, through it, own sense of competence in mathematics. Similarly, the cognitive interference that is intrusive and disturbing task-related worries are predictive of lower achievement (Sarason et al. 1986; Efklides et al. 1997, 1999).

Interest is defined as a preference for a topic and/or positively experienced, situation-specific state when working on a problem (Jones et al. 2012; Krapp 2005; Pintrich and DeGroot 1990). Researchers have argued that for interest to develop in relation to a school subject, it is important that students experience positive emotions related to the activity itself (Pintrich 2000). Control-value theory assumes positive activating emotions such as enjoyment of learning to increase interest and strengthen motivation. Negative deactivating emotions (e.g., boredom) are presumed to be unfavorable for motivation. Conversely, negative activating

[2] Although Pekrun's control-value model is one among the several important motivational or social-cognitive models relevant to this study (e.g., that of Jacquelynne S. Eccles, Paul Pintrich) it is our belief that comprehensiveness of the model and exploration of relationships between particular emotions and different correlates addressed in the study reflect in the most relevant way the theoretical framework necessary for this particular investigation. This is of course a personal opinion of the authors and in no way favors one theoretical framework over the other.

emotions such as *anxiety* are postulated to be more complex and ambivalent—e.g., failure-related anxiety may reduce interest and intrinsic motivation, but can also reinforce motivation allowing a person to invest more work to avoid failure (e.g., Pekrun et al. 2002, 2004). As reported by Macher et al. (2012), students with higher levels of interest in a subject invest more time and effort in learning, apply more effective learning strategies, and achieve better results.

In respect to learning strategies a student may use, the control-value theory assumes that positive activating emotions help choosing flexible learning strategies (e.g., elaboration), while negative activating emotions can enable the use of more rigid strategies, such as repetition (Pekrun et al. 2007). In an everyday classroom context, if a student enjoys learning mathematics, it may be easier for him/her to engage in creative problem solving, whereas anxiety may lead to memorizing specific procedures. Other studies also report anxiety to be linked with the application of cognitive learning strategies and the investment of individual resources such as attention, effort, or time (Cassady and Johnson 2002; Mathews et al. 2000). Earlier, Benjamin et al. (1981) found that anxious students seemed to be the ineffective learners who did not use adequate cognitive learning strategies for achievement, whereas Pintrich and DeGroot (1990) found them to be less persistent at difficult tasks. Cates and Rhymer (2003) suggest more anxious students are more prone to make mistakes and are slower in solving elementary mathematical computations, causing them to achieve poorer test results.

Numerous studies suggest a negative relationship between math anxiety and achievement. A meta-analysis on 26 studies dealing with relationship between anxiety and achievement indicates a statistically negative correlation between the two (−0.27) and the relationship to be consistent across gender, grade-level, ethnic groups, instruments measuring anxiety, and years of publication (Ma 1999). Furthermore, Ma and Cartwright's (2003) results show a more specific path of math anxiety. Students with lower anxiety towards mathematics in Grade 7 are reported to grow faster in mathematics affect[3] outcome in Grade 12 than students with higher anxiety towards mathematics in Grade 7. The control-value theory postulates a complex relationship between emotions and achievement. However, for most task conditions, it is assumed positive activating emotions (e.g., activity-related enjoyment) put forth positive overall effects and negative deactivating emotions (e.g., boredom) set forth negative effects. In respect to anxiety, a negative activating emotion, the theory assumes a complex relationship. Although some studies suggest overall negative effect of anxiety on individual achievement, there are results pointing to the fact that some students can profit from their anxiety as it fosters motivation and achievement (Pekrun et al. 2007).

Gender differences within mathematics domain have been an investigated topic, however in respect to discrete mathematics emotions, the only variable that has been researched extensively is mathematics anxiety. While some studies showed girls experiencing higher levels of anxiety than boys during mathematics tasks and in contexts involving mathematical thinking (Frenzel et al. 2007; Pekrun et al. 2007), other studies show links only at the end of primary schooling with girls' anxiety rising and boys' decreasing at that age (Ma and Cartwright 2003). In a study conducted by Frenzel et al. (2007), girls and boys had received similar grades in mathematics, but girls have reported significantly less enjoyment in mathematics related content and more anxiety. Authors argue that the findings suggested this kind of female emotional pattern due to the girls' low competence beliefs and domain value of mathematics, combined with their high subjective values of math achievement.

Although control-value theory postulates classroom interaction, social environments, and sociohistorical context to affect individual's achievement emotions (Pekrun et al. 2007), issues related to broad context of classroom management and especially classroom discipline seem to

[3] The author describes mathematics affect as a composition of three distinctive dimensions: the attitude towards mathematics, anxiety and utility of mathematics.

be neglected in research. Respectively, disciplinary climate refers to the creation of a classroom atmosphere facilitating the learning process (OECD 2010). Such classrooms are efficient, free of interferences, while on task behaviors are visible for most part of the lesson. In Marzano's (2003) opinion, the classroom management is one of the key factors conducive to effective classrooms. However, to authors' knowledge, the classroom management and more specifically the disciplinary climate have not been investigated in respect to math anxiety.

Finally, studies show the students' perceptions of school in general to be conducive for students learning (OECD 2010). At the international level, countries differ in respect to the level students' attitudes towards school or their general sense of belonging to school contributes achievement. However, the connection between these variables and students' expressed achievement emotions is yet to be determined.

PISA Survey, mathematics' achievement, and students' anxiety

To date, research has mostly relied on statistical procedures intended for only one unit of analysis (e.g., students). Yet, nature of school data is the examples of hierarchical structured records thus requiring simultaneous management of several nested units of analysis, usually students, classes, and schools (Scheerens 2000). The data collected within the PISA study is also hierarchical as students, at one level of analysis, are nested within schools at the next higher level of analysis.

PISA 2003 results confirm negative correlation between anxiety and achievement, pointing also to cultural differences in respect to math anxiety. Students from Japan and Korea (high achievement countries), in addition to students in Tunisia, Brazil and Thailand (low achievement countries) express high math anxiety levels. In contrast, students in Denmark, Netherlands, Finland, and Sweden (all relatively successful countries in math literacy) express low math anxiety (OECD 2010). Despite the differences among students from different countries, one result remains constant—students experiencing math anxiety achieve lower math results.

In respect to the OECD average, the results that students in Serbia achieve on mathematics literacy scale[4] are more than 50 points lower than the OECD average. In the past three PISA cycles, approximately 40 % of students in Serbia were repeatedly falling into functionally illiterate group on mathematics literacy scale (below the PISA level 2). Together, the results from the 2003 study suggested another important feature—high levels of math anxiety (Baucal and Pavlović Babić 2010). In only eight countries, higher levels of math anxiety than in Serbia[5] were reported. More than 60 % of students in Serbia worry about having difficulties in mathematics class or about getting poor grades. Statistically, significant negative correlation between the math achievement and math anxiety was established in all segments of math literacy, including math anxiety and the national mathematics entrance test results (Videnović and Radišić 2011). Linear regression confirms that an increase of math anxiety for one standard deviation leads to a lower math achievement for 32 points[6] and 2 points for the national entrance test in mathematics (out of 20 points). Furthermore, results indicate no statistically significant differences in math anxiety regarding the students' gender in PISA survey 2003. However, girls achieve better results at the national entrance test in mathematics which is school content oriented[7], while the boys are more successful at the PISA survey which is not related to school

[4] Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgments and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen (OECD 2003).

[5] Math anxiety of students in Serbia is significantly higher than the OECD average and is 0.28.

[6] One year of schooling effect in OECD member countries corresponds to 38 points at math literacy scale (OECD 2010).

[7] The girls outperform at the national entrance test in mathematics.

content. Also, boys perceive that they are more efficient in mathematics and show higher degree of interest in mathematics as a school subject. Instrumental motivation in mathematics is more visible among the girls. Pešić and Stepanović (2004) indicated that the most common help students in Serbia seek in the forms of private tutoring are related to mastering math content. Nevertheless, it seems that despite the high effort students invest into this, it does not result with high achievement. The authors postulate that it can be expected that the share of anxiety in explaining achievement of other subject domains is less, as mathematics represents an area in which our students seek help the most. Another possible assumption is that the way mathematics lessons are organized in schools in Serbia "bears" specific difficulties which contribute to math anxiety (Radišić and Baucal 2012).

In the previous research, the most common practice was to establish the association between math anxiety and achievement or some other non-cognitive factor. The share of studies exploring several non-cognitive factors as predictors of math anxiety is lower. The number of studies dealing with at least two level units is even less frequent. They focus on either industrialized or developing countries and usually cover only specific aspects of educational research (e.g., achievement). Nonetheless, they postulate differences between student scores on achievement tests to be more attributable to disparities between individual students than to differences due to attending diverse tutor groups and schools (Teodorović 2012). Since the countries in transition have not extensively participated in these studies, it is not identified whether teacher or school variables associated with student achievement differs in these surroundings considering their different political and socio-cultural backgrounds from those usually researched. Serbia is an exemplary of a country undergoing transition, while at the same time aligning own policies and practices with those of the EU. Results show the period to be marked by discontinuity in designing and implementing educational policies (Dimou 2009; Stanković 2011) while the educational practice is knowledge-oriented. Students are mostly supported in the acquisition of academic knowledge relative to developing key competencies (EU 2002; Eurydice 2010). The dominant form of teaching/learning practice is lecturing (Mincu 2009; EU 2007; Radišić and Baucal 2012), together with passive role of the students and encouragement of memorization.

Therefore, the analyses in this paper are focused on (1) examining the connection between socioeconomic variables, school climate, motivational, and cognitive aspects of learning mathematics and math anxiety at both school and student levels; and (2) identification of clusters of students differing in respect to their attitude towards mathematics. Differences in the achievement between the groups are examined. The authors postulate the results to be informative for all countries in which mathematics content is frontally delivered in a whole-class situation.

Method

Sample

Within every PISA cycle, a student sample is drawn in two steps. First, a sample of schools is selected from a total list of schools controlling the student population of interest (15 years old). Second, a simple random sample of 35 students is drawn from within the selected schools.[8] PISA 2003 survey in Serbia involved a representative sample of students born in 1987

[8] Typically 35 students from the population of 15 years old are at random selected within the selected schools. If fewer than thirty-five 15 years old go to a selected school, then all of the students will be invited to partake.

including 4,405 students from 151 schools; 2,190 girls (49.7 %) and 2,215 boys (50.3 %). The sample was stratified according to geographical regions in Serbia and types of upper secondary schools (grammar schools and types of VET schools).

Instruments

The PISA 2003 assessments consisted of paper-and-pencil tests, whereas the question format varied. Some questions involve students producing simple answers,[9] while other tasks are more constructive, requiring students to produce their own responses.[10] In order to gather contextual information, PISA asks students (and the principals of the schools participating in the study) to respond to background questionnaires. These questionnaires provide information about an array of student and school characteristics.[11]

In the 2003 survey, the central topic of the inquiry was mathematics. Thus, students' questionnaire was dedicated to the examination of the relationship towards mathematics as a school subject. Additionally, a set of questions examining math anxiety was also included in the questionnaire. By virtue of this focus in the 2003 survey, the data provided us with an opportunity to answer the specific questions in relation to math anxiety.

Variables

Central variable of the inquiry is math anxiety *(ANXMAT)*. It represents a composite variable made of 5-Likert type scale items, referring to different aspects of mathematical anxiety (feeling worry, helplessness or nervous when encountering mathematical problems, or worrying about getting poor marks). High anxiety was measured by an agreement with items related to worrying whether one will get good grades in math or feeling helpless and/or nervous when he/she is solving mathematical problems. The internal consistency reliability for the math anxiety scale was (0.82). Four groups of variables were used as predictors of math anxiety (*mathematical achievement, demographical variables, and variables describing school and classroom atmosphere, and variables related to motivational and cognitive aspects in mastering mathematics*). In examining the relationship between math anxiety and achievement, the achievement was defined based on *achievement in mathematics entrance test, global achievement on PISA mathematical literacy scale*, and *midterm school mark in mathematics in the eighth grade*. Variable specifics and examples of scales are given in Table 1. The missing values analysis (using EM algorithm) showed that among all the variables used in the inquiry only two variables had missing values. The variable "*time spent in doing homework in mathematics"* had a rate of 29 % of missing data, while the variable "e*xpected level of education of the student"* exhibited a rate of 0.3 %.[12] The results of linear regression show that there is no system effect in missing to answer to either of the two variables.

[9] A single correct answer within a multiple choice item or closed constructed response items.

[10] Examples of released items may be found at http://www.oecd.org/edu/school/programmeforinternationalstudentassessmentpisa/34993147.zip

[11] The background questionnaires provide information about students' and their family backgrounds; aspects of students' lives (e.g., attitudes to learning and life inside school); strategies of self-regulated learning, motivational preferences and goal orientations; and aspects of learning and instruction (e.g., students' motivation, engagement, and confidence in respect to the major domain of assessment).

[12] In both cases, two new categorical variables were created in order to examine a possible system effect, and value 1 was given to all respondents who did not answer the question.

Table 1 Description of variables used in the analysis

Variable	Description
	Mathematical achievement
Mathematics entrance test (MATENT)	Scores achieved at the national entrance test for admission into secondary school, scores from 0 to 20 (AS=9.24; SE=0.11)
Achievement in PISA mathematical literacy (MATPISA)	Average score in Serbia was 437 points (SE=3.75)
Midterm mathematics school mark in the eighth grade (SCHMARK)	Scores 1 fail; 2 to 5 pass (AS=3.42; SE=0.02)
	Demographical variables
Age	Students would give information on date, month and year of their birth.
Expected level of education of the student (SISCED)	Students expressed desired level of educational attainment; answers were coded in the following categories ISCED 2, ISCED 3B-C, ISCED 3A-4, ISCED 5B, and ISCED 5A-6.
Index of economic, social and cultural status (ESCS)	Represents a composite measure of parents' educational attainment, parents' occupation, parents' occupation prestige, economical status, and cultural resources the family has access to
	School and classroom atmosphere[a]
Teacher support (TEACHSUP)	Example item: "The teacher shows an interest in every student's learning." Positive score on the scale indicates a positive relationship between the students and the teacher.
Disciplinary climate (DISCLIM)	Example item: "Students don't listen to what the teacher says."
Student teacher relations at school (STUREL)	Example item: "Students get along well with most teachers."
Sense of belonging at school (BELONG)	Example item: "I feel like an outsider (or left out of things)."
Attitudes towards school (ATSCHL)	Example item: "School helped give me confidence to make decisions."
	Motivational and cognitive aspects in mastering mathematics
Math anxiety (ANXMAT)	Example items: "I often worry that it will be difficult for me in mathematics classes." and "I feel helpless when doing a mathematics problem.[b]"
Interest in and enjoyment of mathematics (INTMAT)	Example item: "I enjoy reading about mathematics."
Instrumental motivation related to this subject (INSTMOT)	Example item: "Making an effort in mathematics is worth it because it will help me in the work that I want to do later on."
Mathematics self-efficacy (MATHEFF)	Students assessed level of certainty that they can solve 8 types of math problems that were offered e.g., "Understanding graphs presented in newspapers"
Mathematics self-concept (SCMAT)	Example item: "I am just not good at mathematics."
Learning strategies in mathematics (CSTRAT, ELAB, MEMOR)	Control—presence of metacognitive strategies in planning, self-regulation and tracking one's cognition; "When I study for a mathematics

Table 1 (continued)

Variable	Description
	test, I try to work out what are the most important parts to learn.”; Elaboration—linking related content and reflection on alternative solutions; “When I am solving mathematics problems, I often think of new ways to get the answer” and Memory—learning key terms and repetition of the material that was learned; “When I study for mathematics, I try to learn the answers to problems off by heart.”
Time spent in doing homework in mathematics RMHMWK)	The ratio of time spent on mathematics homework and the overall time spent on homework provides an index of relative time spent on mathematics homework

[a] Variables related to school and classroom atmosphere and motivational and cognitive aspects in mastering mathematics were used in accordance with the definitions given in the PISA 2003 Technical report (OECD 2005)

[b] See Appendix for full list of five items used for measurement of the math anxiety in the PISA 2003 study

Plan of analyses

Multiple regression analysis (“stepwise” forward method) was used to examine the possible predictors of math anxiety. The analysis of the data was also conducted using hierarchical linear modeling (HLM). A two level model was used; the student (level-1) and the school level (level-2). Using a sample of schools with a sample of students in a particular grade within each school, a *student-level linear regression model* is estimated for each school in order to predict the association of student characteristics with math anxiety in that grade. This is the level-1 equation. Only the variables that met the criteria in the regression equation were included in the level-1 (Table 2). Simultaneously, a *school-level regression model* is estimated at the school level to predict the association of school characteristics with each of the school-level estimates from the student level models. This is the level-2 equation. Hierarchical cluster analysis was used (Ward method) to examine whether different groups of students may be singled out in respect to their interest in mathematics, learning strategies, self-efficacy in mathematics, and math anxiety.[13] Sampling weight was incorporated in the analysis to account for the complex sampling design of PISA 2003.

Results

Using multiple regression analysis (“stepwise” method), a group of demographical variables, midterm mathematics school mark in the eighth grade, variables related to school and classroom atmosphere, and motivational and cognitive aspects in mastering mathematics were examined as possible predictors of math anxiety (the dependent variable). Ten out of 20 variables used in the analysis significantly improve the ability of the model to predict math anxiety, explaining all together around 40 % of variance ($F(10,3978)=256.580$, $p=0.00$).

[13] All HLM analyses were conducted using HLM version 6.06. Hierarchical cluster analysis was undertaken using SPSS 20.

Table 2 Predictors of math anxiety PISA 2003

		Standardized Beta	SE	R^2 change
Variables included in the equation	SCMAT	−0.474**	0.018	0.280
	MEMOR	0.147**	0.015	0.060
	CSTRAT	0.113**	0.013	0.021
	DISCLIM	−0.106**	0.013	0.011
	MATPISA	−0.091**	0.000	0.006
	BELONG	−0.081**	0.013	0.005
	MATENT	−0.078**	0.002	0.004
	INTMAT	−0.060**	0.016	0.001
	STUREL	0.045**	0.013	0.001
	RMHMWK	0.040**	0.039	0.001
Variables that did not meet the criteria	ESCS			
	TEACHSUP			
	AGE			
	ATSCHL			
	INSTMOT			
	RMHMWK (missing category)			
	SISCED			
	MATHEFF			
	ELAB			
	SCHMARK			

*p<0.05; **p<0.01

Variable ponders, including list of variables that met the criteria and those that did not, are laid out in Table 2. Standard regression was used in order to interpret the R^2 change index.

Consecutive analysis was conducted using the HLM. In this study, level-1 was represented by students' background and their motivational and cognitive aspects in mastering mathematics. Level-2 was represented by instructional practice (disciplinary climate, sense of belonging to school, and teacher-student relationship as defined above, aggregated to school level) and school background variables (the age of students, mathematic entrance test score, sociocultural status, and gender aggregated to school level). Although the results of multiple regressions showed that the ESCS is not a significant predictor of math anxiety, this variable was used in level-2 analysis as a control variable due to high level of differences between schools in Serbia. In order to improve interpretability of the results, all level-1 and level-2 variables, except gender, were grand-mean centered. The grand-mean centering is chosen in the analysis in order to estimate for the between school variance within the math anxiety adjusted for predictors at the individual student level (Kreft et al. 1995).

Models of the study

Using HLM, 26 models were constructed to represent level-1 and level-2 factors of interest.

Model 0: Baseline Model For the baseline model, no level-1 or level-2 variables were included.

$$\text{Y ij} = \text{B0} + \text{Rij}$$
$$\text{B0} = \text{G00} + \text{U0}$$

where Yij is mathematics anxiety score of student i in school j, B0 is regression intercept of school j, G00 is the overall average mathematics anxiety score for all schools, U0 is the random effect of school j, and Rij is the random effect of student i in school j.

Models 1–10: Level-1 student background, motivational, and cognitive aspects in mastering mathematics These models aimed to examine the extent to which student background and their motivational and cognitive aspects in mastering mathematics were associated with math achievement. Variables were entered step by step to make Models 1–9 and thus examine contribution of each of the factors at level 1 and their relationship with achievement. Next, Model 10 as the combined level-1 student background model was built to include all the student variables in a following manner:[14]

$$\begin{aligned} \mathrm{Yij} = {} & \mathrm{B0} + \mathrm{B1} * (\mathrm{BELONG}) + \mathrm{B2} * (\mathrm{DISCLIM}) + \mathrm{B3} * (\mathrm{INTMAT}) + \mathrm{B4} * (\mathrm{SCMAT}) \\ & + \mathrm{B5} * (\mathrm{STUREL}) + \mathrm{B6} * (\mathrm{MATHPISA}) + \mathrm{B7} * (\mathrm{ESCS}) + \mathrm{B8} * (\mathrm{MATENT}) \\ & + \mathrm{B9} * (\mathrm{CSTRAT}) + \mathrm{B10} * (\mathrm{MEMOR}) + \mathrm{B11} * (\mathrm{RMHMWK2}) + \mathrm{Rij} \end{aligned}$$

Models 11–15: Level-2 instructional practices and school background variables These models were built to examine the relationship between instructional practices and school background variables, i.e., what is the contribution of school characteristics irrespective of the characteristics introduced in models 1–10 at the individual level. As in level-1, variables were first entered step by step (Models 11 to 14), and then all level-2 variables were included in the Model 15:[15]

$$\begin{aligned} \mathrm{B0} = {} & \mathrm{G00} + \mathrm{G01} * (\mathrm{BELONG\_M}) + \mathrm{G02} * (\mathrm{DISC\_M}) + \mathrm{G03} * (\mathrm{STUREL\_M}) \\ & + \mathrm{G04} * (\mathrm{ESCS\_M}) + \mathrm{G05} * (\mathrm{MATENT\_M}) + \mathrm{G06} * (\mathrm{GENDER\_PIN}) + \mathrm{U0} \end{aligned}$$

Results of HLM analysis

Baseline model

Approximately 6 % of the total variance in math anxiety is explained by the between schools differences, while 94 % of differences account for the within the school variance. The fixed effect for the intercept was 0.29 (SE=0.024). The data suggest high levels of anxiety within the Serbian student body to be a rather systemic problem, not contributed to a particular school.

Level-1 models

The results obtained from the combined student models suggest that high mathematics self-concept, achievement, and interest in mathematics and school and classroom atmosphere are significantly negative predictors of math anxiety.

It is expected that connection between math self-concept and math anxiety should be strong because these constructs are similar in nature; however, we also believe the influence between

[14] Full variable names are given in Table 1.
[15] Represents ratio between male and female students for each school.

the two to be reciprocal. Surprisingly, the presence of learning strategies and amount of time spent on homework are related with more rather than with less anxiety. One possible interpretation is that students who are not doing well in mathematics spend more time doing homework. Thus, the control and memorization strategies, without the elaboration strategy, are rather used because the material is “learned by hart”, without focusing on its actual understanding. The ESCS is not a significant predictor of math anxiety.

Level-2 models

The use of this combined level-1 and level-2 factors resulted in an increase of explained variance between schools by 0.19 %. The only school level factor that has a significant but minor effect is the ESCS. The higher the school status, the higher is the math anxiety. We postulate that the positive relationship between the index of economic, social, and cultural status at the school level and anxiety may be explained by higher expectations and demands put on the students nested in higher status groups than the ones they originally come from. The ESCS is not significant at the student level, but the coefficient is considerably higher than in the level-1 models (Table 3), indicating that maybe the differences between socioeconomic status of a student and school could be predictors of math anxiety.

Mathematics entrance test and disciplinary climate are significant at the 0.05 level. If a student is nested in a school with better average results at the entrance test and experiences non-strict discipline in mathematics class, his (her) math anxiety will be lower. It is interesting that disciplinary climate at student’s level is in negative relationship with math anxiety. So, a student who attends a math class with high working atmosphere is in a better situation than a student experiencing lack of discipline. At the school level, high discipline climate is related with high anxiety. One way to interpret this difference is that when students from different classes within a school report high discipline in the class, they are actually describing the discipline that goes beyond optimal levels all the way to pure authoritarian organization in the class (Table 4).

Table 3 Parameters estimate for combined level-1 predictors model

Effect	Parameters	Estimates	SE
Fixed Effects	Intercept	0.289**	0.015
	SCMAT	−0.525**	0.022
	MEMOR	0.149**	0.020
	MATPISA	−0.001**	0.000
	DISCLIM	−0.112**	0.018
	CSTRAT	0.098**	0.017
	BELONG	−0.076**	0.014
	MATENT	−0.009**	0.002
	RMHMWK	0.123**	0.040
	INTMAT	−0.066**	0.020
	STUREL	0.0367*	0.016
	ESCS	−0.019	0.016

*$p<0.05$; **$p<0.01$

Table 4 Parameters estimate for combined level-1 and level-2 predictors model

Effect	Parameters	Estimates	SE
Level-1	Intercept	0.323**	0.036
Fixed Effects	SCMAT	−0.525**	0.022
	MEMOR	0.150**	0.020
	MATPISA	−0.001**	0.000
	DISCLIM	−0.115**	0.018
	CSTRAT	0.098**	0.017
	BELONG	−0.076**	0.014
	MATENT	−0.008**	0.003
	RMHMWK	0.126**	0.040
	INTMAT	−0.067**	0.021
	STUREL	0.034*	0.017
	ESCS	−0.031	0.017
	ESCS	0.175**	0.048
Level-2	*MATENT*	−0.013*	0.006
Fixed Effects	*DISCLIM* (school level)	0.119*	0.060
	STUREL (school level)	0.051	0.047
	GENDER	−0.001	0.001
	BELONG (school level)	0.009	0.062

*$p<0.05$; **$p<0.01$

Groups of students differing in respect to their attitude towards mathematics

Based on the hierarchical cluster analysis, three groups of students differing in their interests, anxiety, learning strategies, self-efficacy, and attitude towards mathematics are identified. Based on discriminative analysis, two statistically significant discriminative functions are extracted contributing to the differentiation between the groups. The first one is saturated by variables pointing to the interest and enjoyment in mathematics content and high self-efficacy in mastering the subject ($r=0.75$, df=100, $p=0.00$), and the second discriminative function is comprised of variables pointing to a low self-efficacy in applying mathematics in everyday life, high anxiety in mastering the subject and the usage of memorisation as a learning strategy ($r=0.58$, df=49, $p=0.00$). Eighty-two percent of the students could be accurately classified in the three groups mentioned above.

Students from the first group express high math anxiety and a low self-efficacy in applying mathematical content, with memorisation as the dominant learning strategy (Table 5). This

Table 5 Groups of students differing in their attitude towards mathematics (centroids at discriminative functions)

Groups of students	Functions	
	1	2
Students anxious in mastering and application of math	−0.137	1.088
Non-interested group of students	−1.529	−.541
Students interested in mathematical content	1.196	−.405

group was labeled as *anxious in mastering and application of math*. The second group of students, labeled as *not interested* group, is expressing absence of interest in mathematics and a low efficacy in mastering mathematical content, while their anxiety is not high. Finally, the third group (labeled as *interested in mathematical content*) conveys high interest in math and perceives to be highly efficient in solving math problems.

The groups also differ in achievement in mathematics, including both national entrance test in math ($F=115.298$, $df=2$, $p=0.000$) and math literacy scores at PISA 2003 survey ($F=215.316$, $df=2$, $p=0.000$). The group of students *interested in mathematics* achieves the highest scores, followed by the *non-interested* group, with *anxious* group scoring lowest (Table 6).

Discussion

The focus of this study was on the examination of the relationship between socioeconomic variables, school and classroom climate, motivational and cognitive aspects of learning mathematics and math anxiety at both school and student levels, and the identification of clusters of students differing in respect to their attitude towards mathematics. Results show that approximately 6 % of the total variance in math anxiety is explained between schools differences, while 94 % of differences accounts for the within the school variance. This finding is in line with the results of the two level studies dealing with achievement pointing that the differences between student scores on achievement tests are more attributable to disparities between individual students than to differences due to attending diverse tutor groups and schools (Teodorović 2012). Second, findings in this study speak in favor of a stand that achievement and interest in mathematics, high mathematics self-concept, and school and classroom atmosphere are associated with a lower level of math anxiety. The only school level factor that has a minor, but significant effect is the ESCS index.

Math anxiety variance explained by predictors at the individual level is 40 %. The results indicated that the presence of math anxiety was a more systemic problem than contribution of a particular school. Due to centralized manner of organization of the educational system in Serbia, this result is not surprising and contributes to argument that high levels of math anxiety are the result of general oversights related to organisation of mathematics in our schools. Similar result may be expected in other countries where high levels of mathematics anxiety are present along with more traditional teaching approach and practices related to mathematics.

Mathematics self-concept in mastering mathematics is a variable that showed to be the best predictor, which is in line with the findings of Meece et al. (1990). Nevertheless, it is surprising that the self-efficacy in solving everyday math problems, the elaboration learning strategies, and the intrinsic interest in mathematics do not contribute to explaining of the math anxiety variance. This means that the students, who have an intrinsic interest in the subject, manage to apply knowledge, and use cognitively more demanding learning strategies, are not any less anxious. These findings are not in line

Table 6 Groups of students differing in their relationship towards mathematics and achievement scores

	Anxious group	Non-interested group	Group interested in math content	Total average
MATENT	9.982	12.044	14.174	9.243
MATPISA	419.394	443.787	486.886	437

with those reported by Pintrich (2000) by which for interest and motivation to develop in relation to a school subject, it is important for the students to experience positive affect related to the activity itself. Our results rather favor the complex relationship postulated by the control-value theory (Pekrun et al. 2002, 2004) related to interest and motivation in which anxiety is seen as a factor which may reduce subject related interest and intrinsic motivation, but can also reinforce motivation allowing a person to invest more work to avoid failure. However, our results do not support assumptions of the control-value theory (Pekrun et al. 2007) in respect to the learning strategies a student may use. While the theory assumes anxiety may enable the use of more rigid strategies such as simple repetition, our results clearly show that even students exercising cognitively more demanding learning strategies are not any less anxious.

The results of the analysis also speak in favor of the results contributing to the stand on negative relationship between math anxiety and achievement (e.g., Ma 1999). Again, the control-value theory assumes a complex relationship (Pekrun et al. 2007). Interestingly, coefficients in the results were similar regardless of the domain of mathematical tasks, the national entrance, or PISA test, which significantly differ in their content. Such results confirm the idea that negative relationship between achievement and math anxiety exists regardless of the context in which knowledge is examined (e.g., testing, different content in math, and familiar and less familiar math problems.), meaning also that this relationship is rather strong.

The lack of discipline in class is equally related with higher levels of math anxiety, an aspect which to our knowledge has not been extensively investigated in relation to math anxiety. This was the most significant segment of the school climate explaining the significant percentage of math anxiety variance. The contribution of this variable is even higher than time spent in doing mathematics homework, which somewhat contradicts the results reported by Boekaerts (2007). The segment of school atmosphere is additionally important if the mathematics class is organized in a traditional way with the focus on formal and abstract content of mathematics, as such an organisation demands more energy to maintain students' attention. On the other hand, at the school level, presence of firm school discipline is connected with higher math anxiety and is probably a sign of too strict and rigid atmosphere at school.

Index of socioeconomic status represents the only variable that makes a distinction in respect to the school level factors at the 0.01 significance level. If a student is enrolled in a school of higher average socioeconomic status than own, its math anxiety will be higher. The assumption is that in these particular schools the expectations from the students are also higher. A detailed analysis of meditational variables should give us more information on which variables mediate in this unequal division of math anxiety in respect to schools. Additionally, it should be noted that math anxiety was examined as a composite phenomenon within this study, which is a limitation of the study. Although feeling worry, helplessness, or nervous when encountering mathematical problems or worrying about getting poor marks were built in the 5-item scale used, we did not address specific aspects of math anxiety one by one. Thus, variables mediating the relationship should also be tested in reference to specific aspects of math anxiety.

Based on students' attitudes towards mathematics, the findings point that they can be divided into three clusters. Dimensions that distinguish the clusters are interest in mathematics and presence of math anxiety. The group displaying anxiety scores lowest among the three in math achievement, by which our initial assumption was confirmed. The importance of anxiety and its relationship with achievement is also confirmed by the analysis of students differing in their attitude towards mathematics. Students from the first group, *anxious in mastering and application of mathematics* (high anxiety related to math, low self-efficacy in the subject, and memorisation as a dominant learning strategy) achieve significantly lower results; as an opposite of the other two groups: *non-interested* (lack of interest in math and low self-efficacy in mastering math with low anxiety) and the group labeled as *interested in mathematical content* (high interest in math, high self-efficacy in solving math problems, and low anxiety). This group of findings is in line with earlier findings by Benjamin et al. (1981) that anxious students seemed to be ineffective learners who did not use adequate cognitive learning strategies for achievement and those by Pintrich and DeGroot (1990) and Cates and Rhymer (2003). If we compare the negative influence of math anxiety with lack of motivation, it seems the former hinders achievement more severely.

Further research

This study contributes to the field of inquiry on emotions in educational context by thoroughly exploring individual and school level factors contributing to mathematics anxiety. As countries in economic transition like Serbia have not participated extensively in these studies, this investigation contributes by exploring different political, sociological, and cultural backgrounds from those usually researched. Furthermore, an attempt was made to identify profiles of students relative to math anxiety using hierarchical cluster analysis. As investigation of profiles is always relative to the sample being investigated, these findings need to be confirmed with different trials. Due to the strong need for large-scale and systematic research linking to mechanisms related to math anxiety, based on multiple observations at various time points, contexts, and cultural settings, PISA survey 2012 cycle focus on mathematics will allows us to do so.

In addition, further steps of our inquiry will be focused on investigation of different dimensions of mathematics anxiety and their correlates at individual and school level, in order to determine whether the findings obtained in this study at the level of the general dimensions of mathematics anxiety will be confirmed. Moreover, as PISA data do not allow for the examination of the classroom level factors, auxiliary steps will be focused on the extent teachers are aware of how anxiety contributes students' math achievement, which teachers' practices foster students' math anxiety and which teachers' practices provide a scaffold to students to develop more positive emotions towards learning mathematics. The aims of this kind of studies are to contribute to the field and to examine potential effectiveness of classroom intervention techniques related to reducing anxiety in a class. Also, further analysis would allow examining possible teachers' variables which mediate the relationship between math anxiety and achievement.

Finally, in respect to the results obtained within the current inquiry future studies might include more extensive investigation on contribution of the school level data, especially focusing on characteristics of the school context, that is out how wider school context can contribute to students' math anxiety (e.g. does socioeconomic development of settlements where the school is located makes a difference, does school attractiveness in respect to the enrolment of new students after the compulsory education is related to the math anxiety, and how social status of teachers in the settlement is related to the math anxiety).

Appendix

List of items measuring Math anxiety (ANXMAT)

- I often worry that it will be difficult for me in mathematics classes.
- I get very tense when I have to do mathematics homework.

- I get very nervous doing mathematics problems.
- I feel helpless when doing a mathematics problem.
- I worry that I will get poor marks in mathematics.

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