

Factors That Influence Pupils' Engagement in Learning Mathematics and Their Effects on General Academic Achievement

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Abstract

The purpose of this study was to evaluate factors that influence mathematics motivation in primary school pupils and to investigate the relationship among variables such as gender, general academic success, mathematics achievement and mathematics teachers' characteristics. The study involved 316 primary school pupils, who completed the structured questionnaires. Significant gender-based differences were found in both general academic and mathematics achievement, with mathematics success strongly correlating with overall academic performance. A significant relationship was identified between factors that influence motivation for learning mathematics, mathematics teachers' characteristics and pupils' average mathematics grades. These results suggest that teachers are advised to present mathematics in more innovative and engaging ways.

Key words: average mathematics grades; grade point average; mathematics learning; mathematics motivation; primary school pupils

Introduction

Mathematics is a fundamental branch of science, and it has an essential role in science studies and technological development. It is also important in everyday life. Mathematics provides children with knowledge and skills necessary for life, as well

as the thinking skills needed for problem solving and preparation for the future (Yildirim et al., 2006).

The pupils' motivation for learning mathematics is usually observed as extrinsic and intrinsic motivation (e.g., Afzal et al., 2010). A high grade given by a teacher as a reward to a pupil is an example of extrinsic motivation. A desire for knowledge and development, as well as curiosity, represents intrinsic motivation (see Selcuk, 2000). Teachers should demonstrate attitudes and behaviors that motivate pupils during the learning process (Balantekin & Oksal, 2014). Because of this, motivated students will look for different ways of learning, ask questions and actively participate in classes (see Schunk, 2012).

Pupils' perceptions of mathematics are largely influenced by prejudices developed in the community. They often have negative feelings toward mathematics, which is the biggest problem in the field of mathematics education (see Bai, 2011; Özdemir & Gür, 2011; Yenilmez, 2010). This is usually caused by their negative experiences at school (Jackson & Leffingwell, 1999). Negative experiences in mathematics courses during primary school education usually lead to avoiding mathematics during secondary school (Ashcraft, 2002) and to decreasing confidence in mathematics skills (see Bursal & Paznokas, 2006). Despite numerous studies on math motivation globally, few have examined how Serbian primary pupils perceive their teachers' role in fostering engagement (Milovanovic, 2020; Lawrence & Mihajlović, 2020). Our study provides practical, data-driven recommendations for improving mathematics instruction by defining some motivational factors, math teacher characteristics and provides some valuable insights and findings within the Serbian educational context.

In Serbia, primary education lasts eight years and is divided into two cycles, each consisting of four grades: Cycle I (class teaching) and Cycle II (subject teaching). The school year consists of two semesters, and each semester is divided into two terms: the first semester (Term I, Term II) and the second semester (Term III, Term IV). The grading system in both primary and secondary schools is numerical. The numeric grade is done by using a five-point scale of both qualitative and quantitative assessments: 5 – excellent, 4 – good, 3 – average, 2 – below average, and 1 – failing (see Eurydice: Serbia overview; Eurydice: Serbia: Single-structure primary and secondary education).

The final grade is proposed by the teacher and approved by the school Teachers' Council. The grade point average (GPA) is computed at the end of the first semester as the average of all final grades in that semester, and at the end of the school year based on all grades earned during that year. There are four GPA categories: excellent ($GPA > 4.50$), very good ($3.50 < GPA < 4.49$), good ($2.50 < GPA < 3.49$), and satisfactory ($GPA < 2.49$). GPA cannot be calculated if any final grade is 1.

Therefore, this study aims to (1) identify key positive and negative motivational factors among Cycle II pupils, (2) examine gender differences in math achievement and motivation, and (3) explore how specific teacher characteristics influence pupil engagement.

Methodology

Research design

The objective of this study is to gain a specific or general understanding of the target group across various aspects. It aims to assess the current level of motivation among primary school pupils to learn mathematics, and to explore their views on characteristics that make a good math teacher. The study also examines these perspectives in relation to the students' gender and their grades.

Sample

The descriptive survey was conducted between November and December 2019, at primary schools in Novi Sad, Belgrade and Kraljevo, Serbia. The participants were pupils attending the fifth, sixth, seventh and eighth grades of primary school (Cycle 2). The total number of pupils was 374, of whom 58 were excluded due to incomplete data. In this research, we have used a probability sampling method, which involved the random selection of schools and pupils.

Instruments

A measuring instrument in the form of a 4-point rating scale was standardized by the investigator. The Mathematics Motivation Inventory (MMI) was used in the study. It consisted of four subscales of General Characteristics, Grades, Motivation and Teacher characteristics. The tool was validated and the scale showed adequate reliability, with a coefficient alpha of 0.90.

Data collection

A survey questionnaire was designed based on a literature review and similar research. (Raufelder et al., 2016; Gudelytė et al., 2011). The pupils were invited to participate in the survey during their break time or after attending lectures at school. We used a paper-based questionnaire in which pupils could select one answer or enter the appropriate data. One member of the research team first explained the purpose of the survey to the pupils and assured them that all information would remain completely confidential. Participation was voluntary. During the survey, research team members were available if assistance was required.

The questionnaire consisted of four sections. The first section contained four questions regarding pupils' demographic characteristics, such as gender, place of residence, school name and class.

The second section included a list of six questions designed to assess pupils' school grades for Mathematics and their favorite course at the end of Term I, Mathematics grade at the end of the previous school year and GPA at the end of the previous school year.

The third section included four questions about pupils' feelings and attitudes toward studying mathematics and their satisfaction with the obtained Mathematics grade.

The fourth section included four questions regarding the pupils' motivation for learning mathematics, such as the positive and negative influences on learning mathematics, as

well as characteristics of mathematics teachers that positively or negatively influence pupils and their motivation.

Data analysis

For the analysis of Mathematics grades, favorite subjects and GPA, all grades were divided into four categories: satisfactory (≤ 2.49), good (2.50 – 3.49), very good (3.50 – 4.49) and excellent (4.50 – 5.00).

Data analysis was conducted using the SPSS Statistics computer software package version 21.0. Descriptive statistics (mean (\bar{X}), standard deviation (SD), coefficient of variation (CV), skewness (S) and kurtosis (K)) were used to describe continuous variables. Categorical variables were described using frequency statistics (number and percentage). Differences among the general characteristics of respondents were analyzed using the Chi-square test. The strength of association between significantly related characteristics was calculated using Cramer's ϕ coefficient, interpreted based on the degrees of freedom (see Cohen, 1988). Even though the Fisher's exact test is used for sample sizes < 50 , it was conducted in some cases where it was possible to calculate it (p_e). To test the normal distribution of data, coefficients of variation, skewness and kurtosis, as well as the Kolmogorov-Smirnov test were used (Kim, 2013; Mishra et al., 2019). Differences were considered significant if the p-value was less than 0.05.

Results

The response rate for sample respondents was 85% (316/374). There was an equal number of boys (50 %, 158/316) and girls (50 %, 158/316). Of all respondents, 66 % came from Novi Sad (210/316), 13% from Belgrade (40/316) and 21 % from Kraljevo (66/316).

Descriptive statistics for GPA, final mathematics grades and favorite courses from the previous school year, as well as average marks in mathematics and favorite courses during the quarter, are presented in Table 1.

Table 1
Descriptive statistics for basic grades of pupils ($n = 316$)

Pupils' grades	Measures of data				
	X	SD	CV	Skewness	Kurtosis
General average grade in the previous class	4.50	0.67	14.89	-1.41	1.56
Final mathematics grade in the previous class	4.22	0.99	23.46	-0.99	-0.23
Average mathematics grade for the quarter	4.01	1.08	26.93	-0.58	-1.08
Final favorite courses grade in the previous class	4.83	0.47	9.73	-3.17	11.40
Average favorite courses grade for the quarter	4.75	0.52	10.95	-1.94	2.93

Summary 1. This table shows descriptive statistics of grades, which can suggest possible normality of the data.

In all cases, where the coefficient of variation (CV) was less than 50 %, possible normality of data is suggested. For samples larger than 300, normality depends on the absolute values of skewness and kurtosis. Either an absolute skewness value ≤ 2 or an absolute kurtosis (excess) ≤ 4 may serve as reference values for determining approximate normality. The skewness and kurtosis values in Table 1 indicate that the final favorite courses grade in the previous class does not follow a normal distribution.

Table 2
Basic grades of pupils (n = 316)

Pupils' grades	Gender		Kolmogorov-Smirnov test, p-value
	Male X \pm SD	Female X \pm SD	
General average grade in the previous class	4.3 (0.727)	4.7 (0.532)	KS=5.643; p=0.000*
Final mathematics grade in the previous class	4.0 (0.990)	4.4 (0.952)	KS=4.539; p=0.000*
Average mathematics grade for the quarter	3.8 (1.085)	4.3 (1.028)	KS=5.133; p=0.000*
Final favorite courses grade in the previous class	4.8 (0.574)	4.9 (0.319)	KS=8.950; p=0.000*
Average favorite courses grade for the quarter	4.8 (0.541)	4.8 (0.491)	KS=8.410; p=0.000*

* p<0.05

Summary 2. In this table, values are given for the Kolmogorov-Smirnov test.

The Kolmogorov-Smirnov test values (Table 2) for final mathematics and favorite courses grades in the previous class, as well as average mathematics and favorite courses grades during the quarter, indicate that the data are not normally distributed. Therefore, the parametric t-test cannot be applied (if p<0.05, the data are not normally distributed).

Table 3
The influence of gender on the choice of the most favorite course, on respondents' feelings and attitudes, and the influence on motivation in learning mathematics (n = 316)

	Gender		Total N (%)	χ^2 -test, DF, p-value, Cramer's coef. ϕ
	Male n (%)	Female n (%)		
Serbian language	10 (6%)	6 (4%)	16 (5%)	$\chi^2=50.750$; DF=11; p=0.000*** $\phi=0.401$
Mathematics	18 (11%)	48 (30%)	66 (21%)	
Physical Education	58 (37%)	32 (20%)	90 (28%)	
Chemistry	8 (5%)	5 (3%)	13 (4%)	
History	10 (6%)	20 (13%)	30 (10%)	
Technique and Technology	14 (9%)	0 (0%)	14 (4%)	
English language	6 (4%)	12 (8%)	18 (6%)	
Biology	12 (8%)	14 (9%)	26 (8%)	
Arts	10 (6%)	12 (8%)	22 (7%)	
Geography	4 (3%)	4 (2%)	8 (2%)	
ICT ^a	8 (5%)	2 (1%)	10 (3%)	
German language	0 (0%)	4 (2%)	4 (1%)	

	Gender		Total N (%)	χ^2 -test, DF, p-value, Cramer's coef. ϕ
	Male n (%)	Female n (%)		
I don't enjoy learning mathematics because I don't like it	18 (11%)	12 (8%)	30 (9%)	
I don't enjoy learning mathematics because I don't understand it	22 (14%)	22 (14%)	44 (14%)	$\chi^2=6.227$; DF=4; p=0.183
I don't enjoy learning mathematics, but I understand it	46 (29%)	32 (20%)	78 (25%)	
I enjoy learning mathematics because I understand it	36 (23%)	48 (30%)	84 (27%)	
I enjoy learning mathematics because I love it	36 (23%)	44 (28%)	80 (25%)	
<i>Influence on motivation in learning mathematics</i>				
<i>Positive influence</i>				
Getting new knowledge	46 (29%)	42 (27%)	88 (28%)	$\chi^2=18.548$; DF=7; p=0.010* $\phi=0.242$ pF=0.006***
Possibility of getting a higher mark	68 (43%)	62 (39%)	130 (41%)	
Friend's praise	14 (9%)	4 (3%)	18 (6%)	
Teacher's praise	12 (8%)	28 (18%)	40 (13%)	
Parent's praise	16 (10%)	14 (9%)	30 (11%)	
I have no motivation	0 (0%)	4 (4%)	4 (1%)	
<i>Negative influence</i>				
General lack of interest in learning	38 (24%)	30 (19%)	68 (22%)	$\chi^2=17.634$; DF=5; p=0.003*** $\phi=0.236$ pF=0.002****
Possibility of doing some more interesting things	52 (33%)	40 (25%)	92 (29%)	
Frequent criticism at school	12 (8%)	6 (4%)	18 (6%)	
Non-understandable lecturing	48 (30%)	66 (42%)	114 (36%)	
Lack of opportunities for learning	0 (0%)	10 (6%)	10 (3%)	
Emotional problems	8 (5%)	6 (4%)	14 (4%)	

* p < 0.05

** p < 0.01

*** p < 0.001

**** pF < 0.01

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Summary 3. This table presents the statistically significant relationship between respondents' gender and their favorite course choice (girls – Mathematics; boys – Physical Education), as well as positive and negative influences on learning mathematics (girls – usually “don't understand”; boys – usually “have better things to do”) (p < 0.006).

Favorite course

Table 3 presents the results of the relationship between gender and the choice of favorite course in primary schools. There was a significant relationship in choice of favorite course with respect to gender ($\chi^2 = 50.750$, DF = 11, p < 0.001), and the association is large ($\phi=0.401$). The most favorite course among girls was Mathematics (30 %), while among boys it was Physical Education (37 %).

There was also a significant relationship between the respondents' choice of favorite course and their average Mathematics grade at the end of Term I ($\chi^2= 142.616$, DF = 33, p < 0.001) (Table 4). For respondents with excellent average Mathematics grade, the

favorite course was Mathematics (32 %), for those with good and very good average grades, the favorite course was Physical education (43 % and 37 % respectively), and for respondents with satisfactory average Mathematics grade, the favorite course was Technique and Technology (21 %). This association, measured by Cramer's V coefficient ($\varphi=0.388$), can be considered large.

Respondents' feelings and attitudes

There was no significant relationship between respondents' feelings and attitudes toward mathematics and gender. The most frequent response was that pupils enjoyed learning mathematics because they understood it (27 %). Boys reported that they understood mathematics but did not enjoy learning it (29 %), while girls stated that they both understood and enjoyed it (30 %) (see Table 3).

A significant relationship between respondents' feelings and attitudes toward mathematics and average Mathematics grade at the end of Term I ($\chi^2= 105.606$, $DF = 12$, $p < 0.001$) (see Table 4). Pupils with "excellent" average in Mathematics enjoyed learning mathematics because they understood it (42 %) and because they loved it (31 %). Pupils with "very good" average often did not enjoy learning mathematics, but still understood it (43 %). Those with "good" average (26 %) enjoyed mathematics and loved it. In contrast, 42 % of pupils with "satisfactory" average in Mathematics did not enjoy learning mathematics because they did not understand it, and 26 % did not like it at all. This association was large ($\varphi=0.344$).

Table 4

The relationship between an average Mathematics grade at the end of Term I, on a choice of the favorite course, on respondents' feelings and attitudes, on GPA and Mathematics grade (n = 316)

	Average mathematics grade at the end of Term I ^a					χ^2 -test, DF, p-value, Cramer's coef. φ
	Satisfac. n (%)	Good n (%)	Very good n (%)	Excellent n (%)	Total N (%)	
	<i>Favorite course</i>					
Serbian language	2 (5%)	4 (6%)	4 (7%)	6 (4%)	16 (5%)	$\chi^2=142.616$
Mathematics	2 (5%)	8 (11 %)	8 (13%)	48 (32%)	66 (21%)	DF=33;
Physical Education	6 (16%)	30 (43%)	22 (37%)	32 (21%)	90 (29%)	p=0.000*
Chemistry	0 (0%)	6 (9%)	0 (0%)	6 (4%)	12 (4%)	$\varphi=0.388$
History	6 (16%)	2 (3%)	8 (13%)	14 (9.5%)	30 (10%)	
Technical E.	8 (21%)	0 (0%)	0 (0%)	6 (4%)	14 (4%)	
English language	4 (10%)	4 (6%)	0 (0%)	10 (7%)	18 (6%)	
Biology	0 (0%)	4 (6%)	14 (23%)	8 (5%)	26 (8%)	
Arts	6 (16%)	4 (6%)	4 (7%)	8 (5%)	22 (7%)	

	Satisfac. n (%)	Good n (%)	Very good n (%)	Excellent n (%)	Total N (%)	χ^2 -test, DF, p-value, Cramer's coef. ϕ
Geography	4 (10%)	0 (0%)	0 (0%)	4 (3%)	8 (2%)	$\chi^2=142.616$ DF=33; p=0.000* $\phi=0.388$
Fisics	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	
Informatics	0 (0%)	8 (11%)	0 (0%)	2 (1%)	10 (3%)	
German language	0 (0%)	0 (0%)	0 (0%)	4 (3%)	4 (1%)	

Respondents' feelings and attitudes

I didn't enjoy learning mathematics because I didn't like it	10 (26 %)	8 (11 %)	10 (17 %)	2 (1 %)	30 (9 %)	$\chi^2=105.606$; DF=12; p=0.000* $\phi=0.344$
I didn't enjoy learning mathematics because I didn't understand it	16 (42 %)	12 (17 %)	10 (17 %)	6 (4 %)	44 (14 %)	
I didn't enjoy learning mathematics, but I understood it	4 (11 %)	16 (23 %)	26 (43 %)	32 (21 %)	78 (25 %)	
I enjoy learning mathematics because I love it	8 (21 %)	18 (26 %)	8 (13 %)	46 (31 %)	80 (25 %)	

Average grade in the previous class

<i>GPA in the previous class</i>						
Satisfactory	2 (5 %)	2 (3 %)	0 (0 %)	0 (0 %)	4 (1 %)	$\chi^2=176.908$; DF=9; p=0.000* $\phi=0.432$
Good	2 (5 %)	16 (23 %)	0 (0 %)	4 (3 %)	22 (7 %)	
Very good	28 (74 %)	38 (54 %)	10 (17 %)	8 (5 %)	84 (27 %)	
Excellent	6 (16 %)	14 (20 %)	50 (83 %)	136 (92 %)	206 (65 %)	
<i>Final mathematics grade in the previous class</i>						
Satisfactory	24 (63 %)	4 (6 %)	0 (0 %)	0 (0 %)	28 (9 %)	$\chi^2=299.074$; DF=9; p=0.000* $\phi=0.562$
Good	8 (21 %)	27 (39 %)	4 (7 %)	4 (3 %)	43 (14 %)	
Very good	4 (10.5 %)	31 (44 %)	26 (43 %)	16 (11 %)	77 (24 %)	
Excellent	2 (5 %)	8 (11 %)	30 (50 %)	128 (86 %)	168 (53 %)	

Important factors for the Mathematics grade

Demonstrated knowledge	22 (58 %)	52 (74 %)	40 (67 %)	116 (78 %)	230 (73 %)	$\chi^2=40.370$; DF=12; p=0.000* $\phi=0.206$
Class activity	0 (0 %)	6 (9 %)	6 (10 %)	14 (10 %)	26 (8 %)	
Discipline	4 (10 %)	10 (14 %)	8 (13 %)	8 (5 %)	30 (10 %)	
The teacher's attitude towards the pupil	12 (32 %)	2 (3 %)	6 (10 %)	8 (5 %)	28 (9 %)	
Success in copying from other pupils	0 (0 %)	0 (0 %)	0(0 %)	2 (2 %)	2 (6 %)	

	Satisfac. n (%)	Good n (%)	Very good n (%)	Excellent n (%)	Total N (%)	χ^2 -test, DF, p-value, Cramer's coef. ϕ
<i>The grade is compatible with the level of knowledge</i>						
Yes	24 (63 %)	64 (91 %)	44 (73 %)	142 (96 %)	274 (87 %)	$\chi^2=39.913$; DF=3; p=0.000* $\phi=0.355$ $\phi_F=0.000^{**}$
No, the grade should be higher	14 (37 %)	16 (27 %)	16 (27 %)	6 (4 %)	42 (13 %)	

^aSatisfactory mark ≤ 2.49 ; Good mark 2.50 - 3.49; Very good mark 3.50 - 4.49, Excellent mark > 4.5

*p < 0.001

** $\phi_F < 0.001$

Summary 4. This table shows the statistically significant relationship between respondents' average Mathematics grade at the end of Term I and their favorite course choice (excellent – Mathematics; very good and good – Physical Education), their feelings and attitudes (excellent – love mathematics; very good – understand it; satisfactory – don't like it), key factors affecting their Mathematics grade (many pupils with satisfactory grade believe the teacher's attitude is the main factor), and the compatibility of the grade with the level of knowledge (many respondents believe their grade should be higher) (p = 0.000).

Important factors for the mathematics grade

Significant relationships were found between the average Mathematics grade at the end of Term I and the GPA at the end of the previous school year ($\chi^2 = 176.908$, DF = 9, p < 0.001) and between the average Mathematics grade and the final average Mathematics grade at the end of the previous school year ($\chi^2 = 299.074$, DF = 9, p < 0.001) (Table 4).

Almost 92 % of pupils with an excellent GPA at the end of the previous school year also had an excellent Mathematics grade at the end of Term I. However, 16 % of pupils with excellent and 74 % with very good GPAs received only a satisfactory Mathematics grade at the end of Term I.

Similarly, about 86 % of pupils with an excellent final Mathematics grade at the end of the previous school year maintained excellence at the end of Term I, while 63 % of pupils with a satisfactory previous grade remained at that level. Interestingly, 5 % of those with very good, 3 % with good, and 3 % with satisfactory previous Mathematics grades at the end of the previous school year showed improvement. Conversely, 14 % with excellent, 44 % with very good, and 21 % with good final Mathematics grades at the end of the previous school year showed regression, as their Mathematics grades decreased at the end of Term I. These relationships can be considered as large according to Cramer's V coefficient ($\phi=0.432$, $\phi=0.562$, respectively).

There was also a significant relationship between factors influencing the Mathematics grade and average Mathematics grade at the end of Term I ($\chi^2= 40.370$, DF = 12, p < 0.001). Pupils believed their Mathematics grades were based on their knowledge (73 %), discipline (10 %), teacher's attitude (9 %), classroom participation (8 %), and copying from other pupils (1 %). Interestingly, 32 % of pupils with satisfactory average Mathematics grades thought their grades depended on the teacher's attitude (Table 4). This association was large ($\phi=0.206$).

A significant relationship was found between the pupils' attitude about the fairness of their Mathematics grades and their demonstrated knowledge relative to their average Mathematics grade at the end of Term I ($\chi^2 = 39.913$, $DF = 3$, $p < 0.001$) (Table 4). This relationship was large ($\varphi=0.355$). The Fisher's exact test ($p_F < 0.001$) confirmed this result. Most pupils (87 %) thought that their average mark for Mathematics at the end of Term I was due to their level of belief that their Mathematics grade reflected their demonstrated knowledge, although around 37 % of pupils with a satisfactory average grade thought that their grades should have been higher.

Motivation in learning mathematics

There was a significant relationship between both positive ($\chi^2 = 18.548$, $DF = 7$, $p < 0.05$) and negative ($\chi^2 = 17.634$, $DF = 5$, $p < 0.01$) motivational factors in learning mathematics and gender (Table 3). The Fisher's exact test ($p_F = 0.006$, $p_F = 0.002$) also confirmed statistically significant associations. The most common positive motivational factor for both boys and girls was the possibility of achieving a higher grade (41 %). The most frequent negative motivational factor for girls was non-understandable teaching (42 %), while boys felt they could spend their time better than studying mathematics (33 %). The Cramer's V coefficient ($\varphi = 0.242$, $\varphi = 0.236$) indicates large relationships.

There was also a significant relationship between positive motivational factors and the average Mathematics grade at the end of Term I ($\chi^2 = 53.403$, $DF = 21$, $p < 0.001$) (Table 5). Pupils with excellent, very good, and good mathematics grades cited the possibility of achieving a higher grade (46 %, 43 % and 40 % respectively) and gaining new knowledge (31 %, 17 % and 26 % respectively) as the most positive motivational factors. Pupils with satisfactory Mathematics grades emphasized gaining new knowledge (37 %) and achieving a higher Mathematics grade (21 %) as positive motivators. This association was large ($\varphi = 0.237$).

A significant relationship was also found between negative motivational factors and the average Mathematics grade at the end of Term I ($\chi^2 = 40.717$, $DF = 15$, $p < 0.001$). Most pupils (36 %) considered non-understandable teaching the main negative motivational factor. Pupils with excellent Mathematics grade reported that they could do more interesting things (35 %) and that the lectures were non-understandable (30 %). Pupils with very good average Mathematics grade cited non-understandable lectures (33 %), other more interesting activities (27 %), and a general lack of interest (27 %) as the main negative motivational factors. Also, pupils with good average Mathematics grade reported non-understandable lectures (40 %) and lack of interest (29 %) as the most negative motivational factors. Pupils with satisfactory grade most often mentioned non-understandable lectures (58 %) and doing something more interesting (26 %) as the most negative motivational factors (Table 5). Due to Cramer's V coefficient ($\varphi = 0.207$) this association was large.

Table 5

The relationship between the average Mathematics grade on the motivation in learning mathematics and mathematics teacher's characteristics (n = 316)

	Average mathematics grade at the end of Term I ^a				Total N (%)	χ^2 -test, DF, p-value, Cramer's coef. ϕ
	Satisfac. n (%)	Good n (%)	Very good n (%)	Excellent n (%)		
<i>Factors for motivation in learning mathematics</i>						
<i>Positive influence</i>						
Getting new knowledge	14 (37 %)	18 (26 %)	10 (17 %)	46 (31 %)	88 (28 %)	$\chi^2=53.403$; DF=21; p=0.000*
Achieving a higher grade	8 (21 %)	28 (40 %)	26 (43 %)	68 (46 %)	13 (41 %)	
Friend's praise	4 (11)	10 (14 %)	2 (3 %)	2 (1 %)	18 (6 %)	$\phi=0.237$
Teacher's praise	6 (16 %)	10 (14 %)	8 (13 %)	16 (11 %)	40 (13 %)	
Parent's praise	4 (10 %)	2 (3 %)	10 (17 %)	14 (10 %)	30 (10 %)	
I have no motivation	2 (5 %)	2 (3 %)	4 (7 %)	2 (1 %)	10 (2 %)	
<i>Negative influence</i>						
General lack of interest in learning	6 (16 %)	20 (29 %)	16 (27 %)	26 (18 %)	68 (22 %)	
Possibility of doing some more interesting things	10 (26 %)	14 (20 %)	16 (27 %)	52 (35 %)	92 (29 %)	$\chi^2=40.717$; DF=15; p=0.000*
Frequent criticism at school	0 (0 %)	2 (1 %)	0 (0 %)	16 (11 %)	18 (6 %)	$\phi=0.207$
Non-understandable lecturing	22 (58 %)	28 (40 %)	20 (33 %)	44 (30 %)	114 (36 %)	
Lack of opportunities for learning	0 (0 %)	0 (0 %)	4 (7 %)	6 (4 %)	10 (3 %)	
Emotional problems	0 (0 %)	6 (9 %)	4 (7 %)	4 (3 %)	14 (4 %)	
<i>Characteristics of a Mathematics teacher</i>						
<i>Desirable</i>						
Understandable lecturing	28 (88 %)	54 (85 %)	26 (52 %)	100 (71 %)	208 (73 %)	$\chi^2=37.732$; DF=9; p=0.000*
Fair assesment	4 (12 %)	6 (9 %)	8 (16 %)	8 (6 %)	26 (9 %)	
Dedication to the course	0 (0 %)	2 (3 %)	10 (20 %)	8 (6 %)	20 (7 %)	$\phi=0.210$
Patience	0 (0 %)	2 (3 %)	6 (12 %)	24 (17 %)	32 (11 %)	
<i>Nondesirable</i>						
Non understandable lecturing	6 (21 %)	18 (28 %)	24 (46 %)	48 (39 %)	96 (36 %)	$\chi^2=47.419$; DF=9; p=0.000*
Unfair assessment	12 (43 %)	32 (50 %)	8 (15 %)	18 (14 %)	70 (26 %)	
Strict teacher	10 (36 %)	10 (16 %)	8 (15 %)	36 (29 %)	64 (24 %)	$\phi=0.243$
Inappropriate behavior	0 (0 %)	4 (6 %)	12 (23 %)	22 (18 %)	38 (14 %)	

^aSatisfactory mark ≤ 2.49 ; Good mark 2.50- 3.49; Very good mark 3.50 - 4.49, Excellent mark > 4.5

*p < 0.001

Summary 5. This table summarizes the statistically significant relationship between respondents' average Mathematics grade at the end of Term I and: positive motivational factors (achieving higher marks and gaining new knowledge), negative factors (excellent – possibility of doing something more interesting; all others – unclear lectures), desirable teacher characteristics (clear and understandable lectures), and undesirable teacher characteristics (excellent and very good – unclear lectures; good – unfair grading; satisfactory – teacher's strictness) (p < 0.001).

The most desirable characteristic of a mathematics teacher, according to pupils, was understandable lecturing (73 %). There was a significant relationship between the desirable teacher characteristics and average Mathematics grade at the end of Term I ($\chi^2 = 37.732$, $DF = 9$, $p < 0.001$) (Table 5). This association was large ($\phi=0.210$).

Pupils generally considered the most undesirable teacher characteristics to be non-understandable teaching (36 %), unfair assesment (26 %), strictness (24 %) and inappropriate behavior (14 %). A significant relationship was found between undesirable teacher characteristics and the average Mathematics grade at the end of Term I ($\chi^2 = 47.419$, $DF = 9$, $p < 0.001$), (Table 5). Pupils with excellent and very good average Mathematics grades most often identified non-understandable teaching as the main negative teacher characteristics, while those with satisfactory and good average grade belived they were victims of unfair assesment. This relationship was large ($\phi=0.243$).

Discussion

This study investigated the relationships among gender, average Mathematics grades, and teachers' characteristics in relation to pupils' motivation to learn mathematics, as well as differences in pupils' feelings and attitudes toward motivation. According to the results of our survey, girls most often chose Mathematics as their favorite subject, while boys usually preferred Physical Education. Similarly, Margolis & McCabe (2003) found a significant difference in motivation levels between genders; girls demonstrated greater learning focus, planning, study management, and persistence, while boys showed higher levels of self-sabotage. Motivation levels toward mathematics among sixth, seventh, and eighth-grade pupils, when analyzed by gender and class level, showed that girls had higher motivation than boys (see Oksuz, 2015; Fernandez & Paul, 2022; Arroyo-Barrigüete et al., 2023).

Pupils who understand mathematics tend to enjoy learning it, although some express understanding without enjoyment. Pupils with an excellent general average grade in the previous class also had excellent Mathematics grades, while those with a good average grade in the previous class mostly have a bad Mathematics grade. Motivation to learn mathematics is closely related to academic achievement (Awan et al., 2011; Bobis et al., 2011; Shores & Shannon, 2007). Interestingly, some pupils with good average Mathematics grade reported enjoying mathematics and loving it—possibly due to a lack of consistent discipline or daily practice.

Most pupils believed that demonstrated knowledge was the most important factor influencing their Mathematics grade and that their grades reflected their level of understanding. However, 37 % of pupils with poor Mathematics grades felt that their grades should have been higher and depended largely on the teacher's personal impression, which can contribute to mathematical anxiety. Numerous studies confirm a direct link between student motivation and achievement in mathematics (Shores & Shannon, 2007; Yildirim, 2011).

For our pupils, the most important motivational factors for learning mathematics were the possibility of achieving a higher grade, acquiring new knowledge, and receiving praise from the teacher. Negative factors included unclear lecturing, the belief that mathematics would not be needed in the future, the idea that their time could be spent on more enjoyable activities, and a general lack of interest in mathematics. Hargreaves (1994) suggested that if teachers incorporate psychological principles of motivation into mathematics instruction, pupils might find learning more interesting. A very small number of pupils expressed interest in mathematics, often perceiving it as too abstract and unstimulating (Rudhumbu, 2014). This issue may stem from a lack of sensitivity among teachers to students' individual learning needs.

The characteristics of a mathematics teacher were found to have a strong influence on pupils' motivation to learn. The most desirable teacher characteristic, according to pupils, was the clarity and quality of teaching. When teachers explain material clearly, concisely, and with relevant examples demonstrating practical applications of mathematical concepts, pupils show greater motivation. Other desirable characteristics included patience and fairness in assessment.

Pupils identified poor and unclear lecturing, unfair assessment, and excessive strictness as the most negative teacher characteristics. According to Konesappillai (1995), pupils often dislike mathematics because teachers fail to use effective motivational techniques. When mathematics teaching is innovative, creative, and allows pupils to demonstrate knowledge through problem-solving, it becomes more enjoyable and motivation increases. Teachers should also encourage pupils and build their confidence in success (Yenilmez & Ozbey, 2006; Yunus & Ali, 2009). Furthermore, understanding pupils' general attitudes toward mathematics can help teachers adjust their teaching strategies (Dede & Argun, 2004). Our study provides practical, data-driven recommendations for improving mathematics teaching through motivational factors and math teacher characteristics.

This study has certain limitations. It was conducted on a relatively small sample and may not reflect the attitudes of all Serbian primary school pupils. Therefore, future research should be extended to other schools across Serbia to gain a more comprehensive understanding of pupils' knowledge, feelings, and motivation toward learning mathematics. Based on the results of this study, future research should replicate the design with different samples and include additional variables for a deeper analysis.

Conclusion

The purpose of this study was to investigate the factors that influence motivation for learning mathematics.

The possibility of achieving higher marks can serve as a strong motivator. In other words, higher grades encourage pupils to study harder and adopt more effective learning strategies (Wild, 2023; Liljeröd, 2025). On the other hand, external reward can limit general interest and long-term engagement. Therefore, teachers should balance reward-

based systems with approaches that nurture curiosity (Schunk & DiBenedetto, 2020).

The results showed that there are gender-based differences and that academic achievement is closely related to the average Mathematics grade. Based on this study, it can be concluded that classroom teachers play a major role in pupils' motivation for learning mathematics. Therefore, teachers should use different educational techniques that make mathematics more enjoyable, pay attention to pupils' abilities, and ensure that mathematics remains engaging and motivating for students.

The perception of fairness in grading significantly affects motivation and learning outcomes. Transparent, consistent, and well-explained assessment practices build trust between teachers and pupils. Conversely, perceived unfairness can discourage participation and lead to anxiety and lower academic achievement among both genders (Brookhart, 2012; Black & Wiliam, 1998). In addition, boys often express greater interest in activities outside the classroom.

The clarity of lectures is a very important factor influencing pupils' motivation. Pupils consistently identify understandable explanations as the most positive characteristic of mathematics teachers. Monotonous and unclear lectures reduce motivation and reinforce the perception that mathematics is difficult or irrelevant (Boaler, 2016; Keller & Neuman, 2013). Active, discussion-oriented teaching and use of real-world examples can significantly increase students' interest and retention.

In recent times, some research about the motivation of Serbian pupils has been done. Major issues investigated in Lawrence & Mihajlović (2020) included perceptions of usefulness and enjoyment of mathematics. Also, mathematical anxiety was considered in Milovanovic (2020), and it negatively affects achievement in both genders, which suggests that different motivational strategies may be required. Studies on emotions in mathematics were explored in Rodriguez et al (2020) and showed that often investigators are focused narrowly on math anxiety, overlooking other emotional factors, such as sadness and boredom, which, as forms of "hot cognition," may shape learning and success. Therefore, the primary contribution and originality of this research lie in its integrated examination of gender, emotional factors, and both positive and negative influences on pupils' motivation to learn mathematics.

Some teaching techniques that can be applied include beginning the lessons by giving pupils reasons to be motivated, stating learning objectives, using verbal and written rewards, using tests and grades wisely, occasionally using unexpected activities, presenting familiar examples, encouraging pupils to apply previously learned concepts, integrating simulation and games and minimizing negative experiences related to participants. These techniques are easily applicable in the classroom. Therefore, teachers should actively foster pupils' enthusiasm for mathematics. Because significant gender differences in academic achievement were found, special attention should be given to male pupils to help reduce the motivational gap between boys and girls.

Future research should focus on how self-confidence, a respectful classroom environment, and gender-specific factors interact to shape pupils' motivation. It would

also be valuable to investigate how constructive written feedback, teacher consultations, and formative assessment influence long-term attitudes toward mathematics.

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Čimbenici koji utječu na angažman učenika u učenju matematike i njezini učinci na opće akademsko postignuće

Sažetak

Svrha ovoga istraživanja bila je procijeniti čimbenike koji utječu na motivaciju za učenje matematike učenika osnovne škole te istražiti odnos među varijablama kao što su spol, opći akademski uspjeh, postignuća iz matematike i karakteristike nastavnika matematike. U istraživanju je sudjelovalo 316 učenika osnovne škole koji su ispunili strukturirane upitnike. Značajne razlike temeljene na spolu pronađene su i u općem akademskom i u postignućima iz matematike, pri čemu je uspjeh iz matematike snažno korelirao s ukupnim akademskim uspjehom. Utvrđena je značajna veza između čimbenika koji utječu na motivaciju za učenje matematike, karakteristika nastavnika matematike i prosječnih ocjena učenika iz matematike. Ovi nalazi upućuju na to da se nastavnicima savjetuje da matematiku prezentiraju na inovativnije i zanimljivije načine.

Ključne riječi: motivacija za matematiku; prosječne ocjene iz matematike; prosjek ocjena; učenje matematike; učenici osnovne škole

Uvod

Matematika je temeljna grana znanosti i ima bitnu ulogu u proučavanju znanosti i tehnološkom razvoju. Također je važna u svakodnevnom životu. Matematika djeci pruža znanje i vještine potrebne za život, kao i vještine razmišljanja potrebne za rješavanje problema i pripremu za budućnost (Yildirim i sur., 2006). Motivacija učenika za učenje matematike obično se promatra kao vanjska i unutarnja motivacija (npr. Afzal i sur., 2010). Visoka ocjena koju učitelj daje kao nagradu učeniku primjer je vanjske motivacije. Želja za znanjem i razvojem, kao i znatiželja, predstavljaju unutarnju motivaciju (vidi Selcuk, 2000). Učitelji bi trebali pokazati stavove i ponašanja koja motiviraju učenike tijekom procesa učenja (Balantekin i Oksal, 2014.). Zbog toga će motivirani učenici tražiti različite načine učenja, postavljati pitanja i aktivno sudjelovati u nastavi (vidi Schunk, 2012). Na percepciju učenika o matematici uvelike utječu predrasude razvijene u zajednici. Često imaju negativne osjećaje prema matematici što je najveći problem u području matematičkoga obrazovanja (vidi Bai, 2011; Özdemir i Gür, 2011; Yenilmez, 2010). To je obično uzrokovano njihovim negativnim iskustvima u školi (Jackson i

Leffingwell, 1999). Negativna iskustva u nastavi matematike tijekom osnovnoškolskoga obrazovanja obično dovode do izbjegavanja matematike tijekom srednje škole (Ashcraft, 2002) i do smanjenja samopouzdanja u matematičke vještine (vidi Bursal i Paznokas, 2006.). Unatoč brojnim studijama o motivaciji za matematiku diljem svijeta, malo ih je ispitalo kako srbijanski osnovnoškolci doživljavaju ulogu svojih učitelja u poticanju angažmana (Milovanovic, 2020; Lawrence i Mihajlović, 2020). Naša studija pruža praktične preporuke utemeljene na podacima za poboljšanje nastave matematike, definirajući neke motivacijske čimbenike, karakteristike učitelja matematike te daje neke vrijedne uvide i nalaze unutar srbijanskoga obrazovnog konteksta.

U Srbiji osnovnoškolsko obrazovanje traje osam godina i podijeljeno je u dva ciklusa, od kojih se svaki sastoji od četiriju razreda: prvi ciklus (razredna nastava) i drugi ciklus (predmetna nastava). Školska godina sastoji se od dva polugodišta, a svako polugodište podijeljeno je na dva semestra: prvo polugodište (Prvi semestar, Drugi semestar) i drugo polugodište (Treći semestar, Četvrti semestar). Sustav ocjenjivanja u osnovnim i srednjim školama je numerički. Numerička ocjena se daje korištenjem petostupanjske ljestvice kvalitativnih i kvantitativnih procjena: 5 - izvrstan, 4 - dobar, 3 - prosječan, 2 - ispod prosjeka i 1 - nedovoljan. (vidi Eurydice: Pregled za Srbiju; Eurydice: Srbija: Osnovno i srednjoškolsko obrazovanje s jednom strukturom).

Konačnu ocjenu predlaže učitelj, a odobrava je Učiteljsko vijeće škole. Prosjek ocjena (GPA) izračunava se na kraju prvog polugodišta kao prosjek svih konačnih ocjena u tom polugodištu, a na kraju školske godine na temelju svih ocjena stečenih tijekom te godine. Postoje četiri kategorije prosjeka ocjena: izvrstan ($GPA > 4,50$), vrlo dobar ($3,50 < GPA < 4,49$), dobar ($2,50 < GPA < 3,49$) i zadovoljavajući ($GPA < 2,49$). Prosjek ocjena ne može se izračunati ako je bilo koja konačna ocjena 1.

Stoga je cilj ove studije (1) identificirati ključne pozitivne i negativne motivacijske čimbenike među učenicima drugoga ciklusa, (2) ispitati spolne razlike u postignućima i motivaciji u matematici te (3) istražiti kako specifične karakteristike učitelja utječu na angažman učenika.

Metodologija

Dizajn istraživanja

Cilj ovoga istraživanja je steći specifično ili opće razumijevanje ciljne skupine u različitim aspektima. Cilj je procijeniti trenutačnu razinu motivacije učenika osnovnih škola za učenje matematike i istražiti njihove stavove o karakteristikama koje čine dobrog nastavnika matematike. Studijom se također ispituju te perspektive u odnosu na spol učenika i njihove ocjene.

Uzorak

Deskriptivno istraživanje provedeno je između studenoga i prosinca 2019. u osnovnim školama u Novom Sadu, Beogradu i Kraljevu u Srbiji. Sudionici su bili učenici petog, šestog, sedmog i osmog razreda osnovne škole (2. ciklus). Ukupan broj učenika bio

je 374, od kojih je 58 isključeno zbog nepotpunih podataka. U ovom istraživanju koristili smo metodu vjerojatnosnoga uzorkovanja koja je uključivala slučajni odabir škola i učenika.

Instrumenti

Istraživač je standardizirao mjerni instrument u obliku ljestvice ocjenjivanja od 4 stupnja. U istraživanju je korišten Inventar motivacije za matematiku (MMI). Sastojao se od četiriju podljestvica: Opće karakteristika, Ocjena, Motivacija i Karakteristika nastavnika. Alat je validiran i skala je pokazala odgovarajuću pouzdanost, s koeficijentom alfa od 0,90.

Prikupljanje podataka

Upitnik za anketiranje izrađen je na temelju pregleda literature i sličnih istraživanja (Raufelder i sur., 2016; Gudelytė i sur., 2011). Učenici su pozvani da sudjeluju u anketi tijekom odmora ili nakon pohađanja predavanja u školi. Korišten je upitnik u tiskanom obliku u kojem su učenici mogli odabrati jedan odgovor ili unijeti odgovarajuće podatke. Jedan član istraživačkoga tima prvo je objasnio učenicima svrhu ankete i uvjerio ih da će sve informacije ostati potpuno povjerljive. Sudjelovanje je bilo dobrovoljno. Tijekom ankete članovi istraživačkoga tima bili su dostupni ako je potrebna pomoć.

Upitnik se sastojao od četiriju dijelova. Prvi dio sadržavao je četiri pitanja o demografskim karakteristikama učenika, kao što su spol, mjesto stanovanja, naziv škole i razred.

Drugi dio sadržavao je popis od šest pitanja osmišljenih za procjenu školskih ocjena učenika iz matematike i omiljenoga predmeta na kraju prvoga tromjesečja, ocjene iz matematike na kraju prethodne školske godine i prosjeka ocjena na kraju prethodne školske godine.

Treći dio uključivao je četiri pitanja o osjećajima i stavovima učenika prema učenju matematike te njihovom zadovoljstvu dobivenom ocjenom iz matematike.

Četvrti dio uključivao je četiri pitanja o motivaciji učenika za učenje matematike, kao što su pozitivni i negativni utjecaji na učenje matematike, kao i karakteristike nastavnika matematike koje pozitivno ili negativno utječu na učenike i njihovu motivaciju.

Analiza podataka

Za analizu ocjena iz matematike, omiljenih predmeta i prosjeka ocjena, sve ocjene su podijeljene u četiri kategorije: zadovoljavajuće ($\leq 2,49$), dobro (2,50 - 3,49), vrlo dobro (3,50 - 4,49) i izvrsno (4,50 - 5,00).

Analiza podataka provedena je korištenjem računalnoga programskog paketa SPSS Statistics verzije 21.0. Deskriptivna statistika (srednja vrijednost (X), standardna devijacija (SD), koeficijent varijacije (CV), asimetrija (S) i kurtoza (K)) korištena je za opis kontinuiranih varijabli. Kategoričke varijable opisane su pomoću frekvencijske statistike (broj i postotak). Razlike među općim karakteristikama ispitanika analizirane su

pomoću hi-kvadrat testa. Snaga povezanosti između značajno povezanih karakteristika izračunata je pomoću Cramerova ϕ koeficijenta, interpretiranoga na temelju stupnjeva slobode (vidi Cohen, 1988). Iako se Fisherov egzaktni test koristi za uzorke veličine < 50 , proveden je u slučajevima u kojima ga je bilo moguće izračunati (pF). Za testiranje normalne distribucije podataka korišteni su koeficijenti varijacije, asimetrije i kurtoze, kao i Kolmogorov-Smirnov test (Kim, 2013; Mishra i sur., 2019). Razlike su smatrane značajnima ako je p-vrijednost bila manja od 0,05.

Rezultati

Stopa odgovora za uzorak ispitanika bila je 85 % (316/374). Bio je jednak broj dječaka 50 % (158/316) i djevojčica 50 % (158/316). Od svih ispitanika, 66 % je iz Novog Sada (210/316), 13 % iz Beograda (40/316) i 21 % iz Kraljeva (66/316).

Deskriptivna statistika za prosjek ocjena, konačne ocjene iz matematike i omiljene nastavne predmete iz prethodne školske godine, kao i prosječne ocjene iz matematike i omiljene kolegije tijekom tromjesečja, prikazana je u Tablici 1.

Tablica 1

U svim slučajevima u kojima je koeficijent varijacije (CV) bio manji od 50 %, sugerira se moguća normalnost podataka. Za uzorak veći od 300, normalnost ovisi o apsolutnim vrijednostima asimetrije i kurtoze. Ili apsolutna vrijednost asimetrije ≤ 2 ili apsolutna kurtoza (višak) ≤ 4 mogu poslužiti kao referentne vrijednosti za određivanje približne normalnosti. Vrijednosti asimetrije i kurtoze u Tablici 1 ukazuju na to da konačna ocjena iz omiljenoga nastavnoga predmeta u prethodnom razredu ne slijedi normalnu distribuciju.

Tablica 2

Vrijednosti Kolmogorov-Smirnovljeva testa (Tablica 2) za konačne ocjene iz matematike i omiljenoga predmeta u prethodnom razredu, kao i prosječne ocjene iz matematike i omiljenoga predmeta tijekom tromjesečja, ukazuju na to da podatci nisu normalno distribuirani. Stoga se parametrijski t-test ne može primijeniti (ako je $p < 0,05$, podatci nisu normalno distribuirani).

Tablica 3

Omiljeni nastavni predmet

Tablica 3 prikazuje rezultate odnosa između spola i izbora omiljenoga nastavnoga predmeta u osnovnim školama. Postojala je značajna povezanost u odabiru omiljenoga predmeta s obzirom na spol ($\chi^2 = 50,750$, $DF = 11$, $p < 0,001$) i povezanost je velika ($\phi = 0,401$). Najomiljeniji predmet među djevojčicama bila je Matematika (30 %), dok je među dječacima to bio Tjelesni odgoj (37 %).

Također je postojala značajna povezanost između izbora omiljenoga predmeta ispitanika i njihove prosječne ocjene iz matematike na kraju prvoga tromjesečja

($\chi^2 = 142,616$, $DF = 33$, $p < 0,001$) (Tablica 4). Za ispitanike s izvrsnom prosječnom ocjenom iz matematike omiljeni predmet bila je Matematika (32 %), za one s dobrim i vrlo dobrim prosječnim ocjenama omiljeni predmet bio je Tjelesni odgoj (43 % odnosno 37 %), a za ispitanike sa zadovoljavajućom prosječnom ocjenom iz matematike omiljeni predmet bio je Tehnika i tehnologija (21 %). Ova povezanost, mjerena Cramerovim V koeficijentom ($\varphi = 0,388$), može se smatrati velikom.

Osjećaji i stavovi ispitanika

Nije utvrđena značajna povezanost između osjećaja i stavova ispitanika prema matematici i spolu. Najčešći odgovor bio je da učenici uživaju u učenju matematike jer je razumiju (27 %). Dječaci su izjavili da razumiju matematiku, ali da ne uživaju u učenju (29 %), dok su djevojčice izjavile da je i razumiju i uživaju u njoj (30 %) (vidi Tablicu 3).

Utvrđena je značajna povezanost između osjećaja i stavova ispitanika prema matematici i prosječne ocjene iz matematike na kraju prvog tromjesečja ($\chi^2 = 105,606$, $DF = 12$, $p < 0,001$) (vidi Tablicu 4). Učenici s izvrsnom prosječnom ocjenom iz matematike uživali su u učenju matematike jer su je razumjeli (42 %) i jer su je voljeli (31 %). Učenici s vrlo dobrom prosječnom ocjenom često nisu uživali u učenju matematike, ali su je ipak razumjeli (43 %). Oni s dobrom prosječnom ocjenom (26 %) uživali su u matematici i voljeli su je. Nasuprot tome, 42 % učenika sa zadovoljavajućom prosječnom ocjenom iz matematike nije uživalo u učenju matematike jer je nisu razumjeli, a 26 % ih je uopće nije voljelo. Ova je povezanost bila velika ($\varphi = 0,344$).

Tablica 4

Važni čimbenici za ocjenu iz matematike

Pronađene su značajne veze između prosječne ocjene iz matematike na kraju prvoga tromjesečja i prosjeka ocjena na kraju prethodne školske godine ($\chi^2 = 176,908$, $DF = 9$, $p < 0,001$) te između prosječne ocjene iz matematike i konačne prosječne ocjene iz matematike na kraju prethodne školske godine ($\chi^2 = 299,074$, $DF = 9$, $p < 0,001$) (Tablica 4).

Gotovo 92 % učenika s izvrsnim prosjekom ocjena na kraju prethodne školske godine imalo je i izvrsnu ocjenu iz matematike na kraju prvoga tromjesečja. Međutim, 16 % učenika s izvrsnim i 74 % s vrlo dobrim prosjekom ocjena dobilo je samo zadovoljavajuću ocjenu iz matematike na kraju prvog tromjesečja.

Slično tome, oko 86 % učenika s izvrsnom završnom ocjenom iz matematike na kraju prethodne školske godine zadržalo je izvrsnost na kraju prvoga tromjesečja, dok je 63 % učenika sa zadovoljavajućom prethodnom ocjenom ostalo na toj razini. Zanimljivo je da je 5 % onih s vrlo dobrim, 3 % s dobrim i 3 % sa zadovoljavajućim prethodnim ocjenama iz matematike na kraju prethodne školske godine pokazalo napredak. Suprotno tome, 14 % s izvrsnim, 44 % s vrlo dobrim i 21 % s dobrim završnim ocjenama iz matematike na kraju prethodne školske godine pokazalo je nazadovanje,

kako su im se ocjene iz matematike smanjivale na kraju prvoga tromjesečja. Ove se veze mogu smatrati velikima prema Cramerovom V koeficijentu ($\varphi = 0,432$, $\varphi = 0,562$).

Također je postojala značajna veza između čimbenika koji utječu na ocjenu iz matematike i prosječnu ocjenu iz matematike na kraju prvoga tromjesečja ($\chi^2 = 40,370$, $DF = 12$, $p < 0,001$). Učenici su vjerovali da su njihove ocjene iz matematike temeljene na njihovom znanju (73 %), disciplini (10 %), stavu učitelja (9 %), sudjelovanju u nastavi (8 %) i prepisivanju od drugih učenika (1 %). Zanimljivo je da je 32 % učenika sa zadovoljavajućim prosječnim ocjenama iz matematike smatralo da njihove ocjene ovise o stavu učitelja (Tablica 4). Ova je veza bila velika ($\varphi = 0,206$).

Značajna povezanost pronađena je između stava učenika o pravednosti njihovih ocjena iz matematike i njihova dokazanog znanja u odnosu na prosječnu ocjenu iz matematike na kraju prvoga tromjesečja ($\chi^2 = 39,913$, $DF = 3$, $p < 0,001$) (Tablica 4). Ova povezanost bila je velika ($\varphi = 0,355$). Fisherov egzaktni test ($p_F < 0,001$) potvrdio je ovaj rezultat. Većina učenika (87 %) smatra da je njihova prosječna ocjena iz matematike na kraju prvoga tromjesečja posljedica njihove razine uvjerenja da njihova ocjena iz matematike odražava njihovo dokazano znanje, iako je oko 37 % učenika sa zadovoljavajućom prosječnom ocjenom smatralo da su njihove ocjene trebale biti više.

Motivacija za učenje matematike

Postojala je značajna povezanost između pozitivnih ($\chi^2 = 18,548$, $DF = 7$, $p < 0,05$) i negativnih ($\chi^2 = 17,634$, $DF = 5$, $p < 0,01$) motivacijskih čimbenika u učenju matematike i spola (Tablica 3). Fisherov egzaktni test ($p_F = 0,006$, $p_F = 0,002$) također je potvrdio statistički značajne povezanosti. Najčešći pozitivni motivacijski faktor i za dječake i za djevojčice bila je mogućnost postizanja više ocjene (41 %). Najčešći negativni motivacijski faktor za djevojčice bila je nerazumljiva nastava (42 %), dok su dječaci smatrali da mogu bolje provoditi svoje vrijeme nego učeći matematiku (33 %). Cramerov V koeficijent ($\varphi = 0,242$, $\varphi = 0,236$) ukazuje na velike povezanosti.

Također je postojala značajna povezanost između pozitivnih motivacijskih faktora i prosječne ocjene iz matematike na kraju prvoga tromjesečja ($\chi^2 = 53,403$, $DF = 21$, $p < 0,001$) (Tablica 5). Učenici s izvrsnim, vrlo dobrim i dobrim ocjenama iz matematike naveli su mogućnost postizanja više ocjene (46 %, 43 % i 40 %) te stjecanje novoga znanja (31 %, 17 % i 26 %) kao najpozitivnije motivacijske faktore. Učenici sa zadovoljavajućim ocjenama iz matematike naglasili su da su stjecanje novoga znanja (37 %) i postizanje više ocjene iz matematike (21%) pozitivni motivatori. Ova je povezanost bila velika ($\varphi=0,237$).

Također je pronađena značajna veza između negativnih motivacijskih čimbenika i prosječne ocjene iz matematike na kraju prvoga tromjesečja ($\chi^2 = 40,717$, $DF = 15$, $p < 0,001$). Većina učenika (36 %) smatrala je nerazumljivu nastavu glavnim negativnim motivacijskim čimbenikom. Učenici s izvrsnom ocjenom iz matematike izjavili su da mogu raditi zanimljivije stvari (35 %) i da su predavanja bila nerazumljiva (30 %). Učenici s vrlo dobrom prosječnom ocjenom iz matematike naveli su nerazumljiva

predavanja (33 %), druge zanimljivije aktivnosti (27 %) i opći nedostatak interesa (27 %) kao glavne negativne motivacijske čimbenike. Također, učenici s dobrom prosječnom ocjenom iz matematike izjavili su da su nerazumljiva predavanja (40 %) i nedostatak interesa (29 %) najnegativniji motivacijski čimbenici. Učenici sa zadovoljavajućom ocjenom najčešće su spominjali nerazumljiva predavanja (58 %) i bavljenje nečim zanimljivijim (26 %) kao najnegativnije motivacijske čimbenike (Tablica 5). Zbog Cramerova V koeficijenta ($\varphi = 0,207$) ova je povezanost bila velika.

Tablica 5

Najpoželjnija karakteristika nastavnika matematike, prema učenicima, bila je razumljivo predavanje (73 %). Postojala je značajna povezanost između poželjnih karakteristika nastavnika i prosječne ocjene iz matematike na kraju prvoga tromjesečja ($\chi^2 = 37,732$, $DF = 9$, $p < 0,001$) (Tablica 5). Ova je povezanost bila velika ($\varphi = 0,210$).

Učenici su općenito smatrali najnepoželjnijim karakteristikama nastavnika nerazumljivo poučavanje (36 %), nepravedno ocjenjivanje (26 %), strogost (24 %) i neprimjereno ponašanje (14 %). Pronađena je značajna povezanost između nepoželjnih karakteristika nastavnika i prosječne ocjene iz matematike na kraju prvoga tromjesečja ($\chi^2 = 47,419$, $DF = 9$, $p < 0,001$) (Tablica 5). Učenici s izvrsnim i vrlo dobrim prosječnim ocjenama iz matematike najčešće su identificirali nerazumljivu nastavu kao glavnu negativnu karakteristiku nastavnika, dok su oni sa zadovoljavajućim i dobrim prosječnim ocjenama smatrali da su žrtve nepravednoga ocjenjivanja. Taj je odnos bio velik ($\varphi = 0,243$).

Diskusija

U ovoj studiji istraživao se odnos između spola, prosječnih ocjena iz matematike, karakteristika nastavnika u odnosu na motivaciju učenika za učenje matematike, kao i razlike u osjećajima i stavovima učenika prema motivaciji. Prema rezultatima naše ankete, djevojčice su najčešće birale Matematiku kao svoj omiljeni predmet, dok su dječaci obično preferirali Tjelesni odgoj. Slično tome, Margolis i McCabe (2003.) otkrili su značajnu razliku u razinama motivacije između spolova; djevojčice su pokazale veći fokus na učenje, planiranje, upravljanje učenjem i upornost, dok su dječaci pokazali veću razinu samosabotaže. Razina motivacije za matematiku među učenicima šestoga, sedmoga i osmoga razreda, analizirana prema spolu i razredu, pokazala je da djevojčice imaju veću motivaciju od dječaka (vidi Oksuz, 2015; Fernandez i Paul, 2022; Arroyo-Barrigüete i sur., 2023).

Učenici koji razumiju matematiku obično uživaju u učenju, iako neki izražavaju razumijevanje bez uživanja. Učenici s izvrsnom općom prosječnom ocjenom u prethodnom razredu također su imali izvrsne ocjene iz matematike, dok oni s dobrom prosječnom ocjenom u prethodnom razredu uglavnom imaju lošu ocjenu iz matematike. Motivacija za učenje matematike usko je povezana s akademskim postignućima (Awan i sur., 2011; Bobis i sur., 2011; Shores i Shannon, 2007). Zanimljivo je da neki učenici s dobrom prosječnom ocjenom iz matematike uživaju u učenju matematike i vole je.

Vjerojatno nisu dovoljno disciplinirani za svakodnevno vježbanje. Zanimljivo je da su neki učenici s dobrim ocjenama iz matematike izjavili da uživaju u matematici i vole je - moguće zbog nedostatka dosljedne discipline ili svakodnevne vježbe.

Većina učenika smatra da je dokazano znanje najvažniji čimbenik koji utječe na njihovu ocjenu iz matematike i da njihove ocjene odražavaju njihovu razinu razumijevanja. Međutim, 37 % učenika s lošim ocjenama iz matematike smatralo je da su njihove ocjene trebale biti više i da su uvelike ovisile o osobnom dojmu učitelja, što može doprinijeti matematičkoj anksioznosti. Brojne studije potvrđuju izravnu vezu između motivacije učenika i postignuća u matematici (Shores i Shannon, 2007; Yildirim, 2011).

Za naše učenike najvažniji motivacijski čimbenici za učenje matematike bili su mogućnost postizanja više ocjene, stjecanje novoga znanja i primanje pohvale od učitelja. Negativni čimbenici uključivali su nejasno predavanje, uvjerenje da matematika neće biti potrebna u budućnosti, ideju da bi svoje vrijeme mogli provesti u ugodnijim aktivnostima i opći nedostatak interesa za matematiku. Hargreaves (1994) je sugerirao da bi učenici mogli smatrati učenje zanimljivijim ako učitelji uključe psihološke principe motivacije u nastavu matematike. Vrlo mali broj učenika izrazio je interes za matematiku, često je doživljavajući kao previše apstraktnu i nestimulirajuću (Rudhumbu, 2014). Ovaj problem može proizaći iz nedostatka osjetljivosti među učiteljima za individualne potrebe učenika za učenjem.

Utvrđeno je da karakteristike učitelja matematike imaju snažan utjecaj na motivaciju učenika za učenje. Najpoželjnija karakteristika učitelja, prema ispitanim učenicima, bila je jasnoća i kvaliteta poučavanja. Kada učitelji jasno, sažeto i s relevantnim primjerima koji pokazuju praktičnu primjenu matematičkih koncepata, učenici pokazuju veću motivaciju. Druge poželjne karakteristike uključivale su strpljenje i pravednost u ocjenjivanju.

Učenici su kao najnegativnije karakteristike učitelja naveli loše i nejasno predavanje, nepravedno ocjenjivanje i pretjeranu strogost. Prema Konesappillaiju (1995), učenici često ne vole matematiku jer učitelji ne koriste učinkovite motivacijske tehnike. Kada je nastava matematike inovativna, kreativna i omogućuje učenicima da demonstriraju znanje rješavanjem problema, postaje ugodnija i motivacija raste. Učitelji bi također trebali poticati učenike i graditi njihovo samopouzdanje u uspjeh (Yenilmez i Ozbey, 2006; Yunus i Ali, 2009). Nadalje, razumijevanje općih mišljenja učenika o matematici može pomoći učiteljima da prilagode svoje nastavne strategije (Dede i Argun, 2004). Naša studija pruža praktične, podatke utemeljene preporuke za poboljšanje nastave matematike putem motivacijskih čimbenika i karakteristika učitelja matematike.

Ova studija ima određena ograničenja. Provedena je na relativno malom uzorku i možda ne odražava stavove svih učenika osnovnih škola u Srbiji. Stoga bi buduća istraživanja trebala biti proširena na druge škole diljem Srbije kako bi se steklo sveobuhvatnije razumijevanje znanja, osjećaja i motivacije učenika za učenje matematike. Na temelju nalaza ove studije, buduća istraživanja trebala bi replicirati dizajn s različitim uzorcima i uključiti dodatne varijable za dublju analizu.

Zaključak

Svrha ove studije bila je istražiti čimbenike koji utječu na motivaciju za učenje matematike. Mogućnost postizanja viših ocjena može poslužiti kao snažan motivator. Drugim riječima, viša ocjena potiče učenika na marljivije učenje i usvajanje učinkovitijih strategija učenja (Wild, 2023, Liljeröd, 2025). S druge strane, vanjska nagrada može ograničiti opći interes i dugoročni angažman. Stoga bi učitelji trebali uravnotežiti sustave temeljene na nagradama s pristupima koji potiču znatiželju (Schunk i DiBenedetto, 2020).

Rezultati su pokazali da postoje razlike temeljene na spolu i da je akademski uspjeh usko povezan s prosječnom ocjenom iz matematike. Na temelju ove studije može se zaključiti da učitelji igraju važnu ulogu u motivaciji učenika za učenje matematike. Stoga bi učitelji trebali koristiti različite obrazovne tehnike koje matematiku čine ugodnijom, obraćati pozornost na sposobnosti učenika i osigurati da matematika ostane zanimljiva i motivirajuća za učenike. Percepcija pravednosti u ocjenjivanju značajno utječe na motivaciju i ishode učenja. Transparentne, dosljedne i dobro objašnjene prakse ocjenjivanja grade povjerenje između učitelja i učenika. Suprotno tome, percipirana nepravda može obeshrabriti sudjelovanje i dovesti do anksioznosti i nižega akademskog postignuća kod obju spolova (Brookhart, 2017, Black & Wiliam, 1998). Osim toga, dječaci često pokazuju veći interes za aktivnosti izvan učionice. Jasnoća predavanja vrlo je važan čimbenik koji utječe na motivaciju učenika. Učenici dosljedno identificiraju razumljiva objašnjenja kao najpozitivniju karakteristiku nastavnika matematike. Monotona i nejasna predavanja smanjuju motivaciju i pojačavaju percepciju da je matematika teška ili nebitna (Boaler, 2016; Keller i Neuman, 2013). Aktivna nastava usmjerena na raspravu i korištenje primjera iz stvarnoga svijeta mogu značajno povećati interes i zadržavanje učenika.

U novije vrijeme provedena su neka istraživanja o motivaciji srpskih učenika. Glavna pitanja istražena u Lawrenceu i Mihajloviću (2020) uključivala su percepciju korisnosti i uživanja u matematici. Također, prema Milovanović (2020) matematička anksioznost negativno utječe na postignuća kod oba spola, što sugerira da bi mogle biti potrebne različite motivacijske strategije. Studije o emocijama u matematici istražene su u radu Rodrigueza i suradnika (2020) i pokazale su da se istraživači često usredotočuju na strah od matematike, previđajući druge emocionalne čimbenike, poput tuge i dosade, koji, kao oblici „vruće spoznaje“, mogu oblikovati učenje i uspjeh. Stoga primarni doprinos i originalnost ovoga istraživanja jest u njegovom integriranom ispitivanju spola, emocionalnih čimbenika te pozitivnih i negativnih utjecaja na motivaciju učenika za učenje matematike.

Neke tehnike poučavanja koje se mogu primijeniti uključuju započinjanje nastave davanjem učenicima razloga za motivaciju, navođenje ciljeva učenja, korištenje usmenih i pismenih nagrada, mudro korištenje testova i ocjena, povremeno korištenje neočekivanih aktivnosti, predstavljanje poznatih primjera, poticanje učenika na primjenu prethodno

naučenih koncepata, integriranje simulacija i igara te minimiziranje negativnih iskustava povezanih s polaznicima. Ove tehnike lako se primjenjuju u učionici. Stoga bi učitelji trebali aktivno poticati entuzijizam učenika za matematiku. Budući da su pronađene značajne spolne razlike u akademskim postignućima, posebnu pozornost treba posvetiti muškim učenicima kako bi se smanjio motivacijski jaz između dječaka i djevojčica.

Buduća istraživanja trebala bi se usredotočiti na to kako samopouzdanje, poštovanje u učionici i rodno specifični čimbenici međusobno djeluju na oblikovanje motivacije učenika. Također bi bilo vrijedno istražiti kako konstruktivne pisane povratne informacije, konzultacije s nastavnicima i formativno ocjenjivanje utječu na dugoročne stavove prema matematici.