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Determinants of Students' Mathematics Self-Concept: Analysis of Gender Universalities and Specificities[1]

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Abstract

The aim of the research was to examine the role that personality variables, mathematics anxiety, stereotypes about mathematics as a male domain and the perception of mathematics teachers' role and behaviour have in explaining students' mathematics self-concept, over and above the information about their mathematics success. The participants were 8th grade students from 36 primary schools from Zagreb and the Zagreb County (N=511). The analysis of the contribution of the above-mentioned predictors was conducted on male and female samples separately. Hierarchical regression analyses revealed the contributions of individual variables and the overall contribution to the explanation of boys' (R=0.63) and girls' (R=0.72) mathematics self-concept. Mathematics success was the strongest determinant of mathematics self-concept for both gender groups. Personality, i.e. conscientiousness was the gender-specific determinant that only contributed to the explanation of girls' mathematics self-concept. The opposite was true for stereotypes about mathematics. Mathematics anxiety and the perception of teachers' role and behaviour were gender-universal determinants. The findings can serve to inform evidence-based planning and implementation of both gender universal and specific interventions for the enhancement of mathematics self-concept.

Key words: *gender differences; math anxiety; math self-concept; personality.*

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Introduction

Beliefs about one's own personal characteristics and abilities that a person holds on the basis of his/her own experiences and comparison with others affect his/her attitude towards a particular task and his/her success in it. Thus a person who feels competent will achieve more than an individual of the same abilities who perceives his/her problem-solving competence as lower (Marsh, 2005).

This perception is referred to in research literature as *self-concept* (Shavelson, Hubner, & Stanton, 1976). Self-concept is a multidimensional construct comprising relatively independent concepts which represent the self-concept of a person in different domains of functioning (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2006).

Academic self-concept has shown to have a key role in predicting educational outcomes (Marsh & Craven, 2006). Research has revealed that academic self-concept is related to positive attitudes towards school, the interest for a particular school subject, the choice of adequate learning strategies, perseverance in performing different academic tasks and to educational achievement and aspirations (Craven & Marsh, 2008; Green, Liem, Martin, Colmar, Marsh, & McInerney, 2012; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Möller, Pohlmann, Köller, & Marsh, 2009).

This paper focuses on mathematics self-concept as part of academic self-concept. Research has shown that one's perception of his/her mathematics ability has a key role in choosing and maintaining adaptive behaviour when learning mathematics (Trautwein, Lüdtke, Roberts, Schnyder, & Niggli, 2009), in the choice of a career path in the area of science, technology or mathematics, and in successful enrolment in higher education institutions (Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014).

The type of mathematics self-concept students develop largely depends on their success in mathematics. Numerous studies have confirmed the reciprocal relationship between mathematics self-concept and success in mathematics (e.g. Kurtz-Costes, Rowley, Harris-Britt, & Woods, 2008; Ma & Kishor, 1997; Marsh et al., 2006). This relationship has been established cross-culturally, on the results obtained by the PISA[2] investigation in 26 countries (Marsh & Hau, 2004). Reciprocal influences of self-concept and achievement can be observed in the frame of reference model (Marsh & Hau, 2004), whose universality has been confirmed regardless of gender, age or country of origin of the participants in the research (Möller et al., 2009). When comparing their success in a particular school subject with that of their peers, students use an external frame of reference. If they assess themselves as successful, students will have a good self-concept in that school subject. An internal frame of reference assumes that students will compare their success (e.g. in mathematics) with their success in other school subjects. If their success in mathematics is better than their achievement in other subjects, students will have a positive mathematics self-concept, even if they are not particularly successful in mathematics when compared with other students.

[2] Programme for International Student Assessment, OECD

Similarly to the relationship between academic self-concept and achievement (Craven & Marsh, 2008), the relationship between personality factors, such as conscientiousness and openness, and academic achievement is well documented (Poropat, 2009). However, these two personality systems are rarely analysed together in relation to different aspects of academic behaviour, partly because they belong to different research traditions. The dimensional approach within personality psychology considers perceptions of one's own competences to be characteristic adaptations to the environment which are, to a great extent, the manifestations of conscientiousness in a specific academic context (McCrae & Costa, 1999). Thus, conscientiousness predicts academic achievement indirectly, through beliefs about one's own competence. The tradition within educational research maintains that academic self-concept and self-efficacy[3] can be predicted by the effort invested in learning and success, independently from personality traits. In research dealing with learning and success in mathematics both models have gained a certain empirical support. Conscientiousness and beliefs about one's own competence are independent predictors of the effort invested in the learning of mathematics (Trautwein et al., 2009). Conscientiousness is indirectly associated to success in mathematics through mathematical self-efficacy (Puklek Lepuvšček, Zupančič, & Sočan, 2013). The relatively scarce research on the relationship between personality and self-concept reports the relations of academic self-concept with conscientiousness and openness (Marsh et al., 2006).

Research on mathematics anxiety also plays a significant role in understanding students' achievement in and experiences with that particular school subject. Meta-analyses point at the negative correlation of mathematics anxiety and mathematics achievement (Hembree, 1990; Ma, 1999). The last PISA investigation has shown that girls experience a significantly higher level of anxiety and other negative emotions concerning mathematics in comparison with boys in 52 of the 65 investigated countries, including Croatia (OECD, 2013). Nevertheless, some studies have not revealed any gender differences regarding mathematics anxiety or reported very small ones (Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Ma, 1999). A reason for such contradictory results might lie in the way mathematics anxiety was measured. Namely, girls express higher anxiety when measured as a stable disposition, whereas situationally-induced fear during mathematics classes or in test situations did not reveal any gender differences (Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013).

Self-concept depends both on internal characteristics and on the environment and students' experiences (Marsh et al., 2006), with the student-teacher relationship being among the most important contextual factors, having a small but significant role in students' achievement, particularly in affective and motivational educational outcomes (Roorda, Koomen, Spilt, & Oort, 2011; Wubbels & Brekelmans, 2006). Students who

[3] Self-concept represents a general image of oneself in particular areas of action, whereas self-efficacy refers to the expectations and beliefs a person holds about his/her own success in particular situations (Bong & Skaalvik, 2003). Although somewhat different, both constructs predict academic motivation, emotions and success.

perceive their teachers as caring and supportive are more motivated for learning and more successful in their social, emotional and academic functioning (Roeser, Eccles, & Sameroff, 2000). Although scarce, research results on the role of the teacher in the formation of academic self-concept indicate that some dimensions of the teacher-student relationship are correlated with higher student mathematics self-efficacy (Hughes, 2011; Puklek Lepuvšček et al., 2013).

The gender dimension of mathematics self-concept is well documented in research. In a meta-analysis including representative national samples of students from about sixty countries, Else-Quest, Hyde and Linn (2010) found consistently higher self-concept in boys. On the samples of students from the USA, Australia and Germany, Nagy, Watt, Eccles, Trautwein and Lüdtke (2010) observed that the difference in mathematics self-concept in favour of boys consistently persisted throughout secondary education.

The aim of the present study is to examine the role of personality variables, mathematics anxiety, stereotypes about mathematics as a traditionally male domain (hereafter: stereotypes about mathematics) and the perception of the role and behaviour of mathematics teachers (hereafter: perception of teacher role) in explaining students' mathematics self-concept, over and above their mark in mathematics. Student characteristics (personality and mathematics anxiety) as well as their perception of the environment in which the teaching and learning of mathematics occur (the acceptance of stereotypes about mathematics and the perception of teacher role) have been included, besides the marks students achieved in mathematics, in order to analyse the potential contribution of these variables to explaining the phenomenon of mathematics self-concept.

Methodology

Participants and Procedure

The participants were eighth-grade students from 36 primary schools from Zagreb and the Zagreb County. The sample of students was representative, stratified according to size and the rural-urban location of the school. Data collection was carried out at two time points. First, a questionnaire assessing various aspects of students' mathematical competence was administered. Two weeks later, personality and mathematics self-concept questionnaires were administered. This paper is based on the data collected on a sample of students who participated in both parts of the research (N=511, 56% girls). At both time points the data collection was carried out in the classroom and lasted 45 minutes. Participants were granted anonymity and parents' consent was obtained.

Instruments

Mathematics self-concept was assessed by the Croatian version of the mathematics self-concept scale from the *Self-Description Questionnaire – II* (Marsh, 1990), which was

created to measure self-concept in younger adolescents. The students were asked to read 10 simple statements (e.g. "Mathematics is one of the subjects I am best at."), and assess their endorsement of the statements on a scale from 1 ("does not describe me at all") to 6 ("describes me very well"). A higher result on the scale indicates a higher level of mathematics self-concept. The reliability of the scale on this sample is α=0.928.

The variable *mathematics achievement* was created as the mean of mathematics marks at three time-points: half-year and end-of-year mark in the 7th grade and half-year mark in the 8th grade (α=0.946). Aggregation of school marks was performed in order to obtain a more stable measure of achievement in mathematics.

Personality was measured by the Croatian translation of the *BFI* questionnaire for children (John & Srivastava, 1999). The questionnaire measures the characteristics of a five-factor personality model; extraversion (α=0.733), agreeableness (α=0.712), conscientiousness (α=0.767), neuroticism (α=0.730) and openness (α=0.711). It comprises 44 statements which describe personal characteristics (e.g. "I see myself as someone who perseveres until he/she finishes a task."). The task of the participants is to express their agreement with each of the statements on a 5-point Likert-type scale (from "1- strongly disagree" to "5- strongly agree").

Mathematics anxiety was tested by a scale which was adapted with the authors' permission from the *Scale for Measuring Math Anxiety* (Arambašić, Vlahović-Štetić, & Severinac, 2005). The scale was originally constructed for use with secondary school students, therefore some statements have been omitted for use with primary school students (α=0.916). Our scale contained 16 situations related to mathematics which the students might encounter (e.g. "When I write a math test…"). The participants' task was to assess the extent to which they felt anxious in a particular situation, on a scale from 1 ("I am not anxious") to 4 ("I am terribly anxious"). A higher result on the scale refers to a higher intensity of mathematics anxiety.

The scale measuring *stereotypes about mathematics as a male domain* was developed for the purpose of this research (α=0.901). It comprised 7 statements which tested the participants' degree of agreement with sentences that describe mathematics as a traditionally male domain, such as "Girls often have to try harder than boys to achieve the same success in maths". Agreement with the statements was marked on a scale from 1 to 4, 1 meaning "strongly disagree", and 4 meaning "strongly agree". Principal component analysis identified one component responsible for the correlations among items, explaining 62.96% of the variance. A higher score on the scale suggests a stronger acceptance of stereotypes about mathematics.

The scale of *beliefs about the role and behaviour of mathematics teachers* was adapted for this research (α=0.920) according to the subscale of the same name from the *Mathematics-related belief questionnaire* (Op't Eynde & De Corte, 2004). A shorter variant of the scale comprised 9 items describing the behaviour of mathematics teachers (e.g. "Our teacher thinks that the mistakes we make are useful as long as we learn from them."), where students expressed their agreement with the statements on

a scale from 1 ("strongly disagree") to 4 ("strongly agree"). The principal component analysis revealed one component explaining 61.42% of the overall variance. A higher score points to a more pronounced perception of supportive behaviour of mathematics teachers.

Results

Since gender differences were observed and following recommendations that a separate analysis of self-concept of boys and girls is more informative (Ma & Kishor, 1997), the analysis was carried out on gender-separated samples. Table 1 shows the arithmetic means and the standard deviations of the results for girls (*N*=284) and boys (*N*=223)[4] as well as the results of t-tests, which were used to test gender differences on the relevant variables.

Table 1

*Means and standard deviations (in brackets) of results for female and male students and results of t-tests for gender differences (** p < 0.01; *p < 0.05).*

	Female students	Male students	t
Mathematics self-concept	3.59 (1.36)	3.58 (1.23)	0.10
Mathematics achievement	3.80 (1.06)	3.38 (1.10)	4.36**
Extraversion	30.62 (5.86)	29.46 (4.87)	2.34*
Agreeableness	32.66 (5.81)	30.57 (4.96)	4.14**
Conscientiousness	30.19 (6.28)	30.12 (5.84)	0.13
Neuroticism	23.17 (5.76)	20.63 (4.98)	5.07**
Openness	36.73 (6.21)	34.08 (5.77)	4.71**
Mathematics anxiety	2.00 (0.65)	1.84 (0.58)	2.82**
Stereotypes about mathematics	1.65 (0.70)	1.93 (0.74)	-4.26**
Perception of teacher role	2.95 (0.75)	2.91 (0.86)	0.01

The mean results on the mathematics self-concept scale are almost identical for boys and girls. Both samples show a moderate level of mathematics self-concept. On the other hand, boys and girls show different means on a range of other variables. Girls have achieved significantly higher results on the variables of mathematics achievement and mathematics anxiety. Although they have very good marks in mathematics and achieve better school results than boys, girls report more anxiety related to mathematics. Nevertheless, it has to be emphasised that the difference in mathematics anxiety is relatively small and that both boys and girls state, on average, that they experience only a slight anxiety in relation to mathematics. Both boys and girls, on average, disagree that mathematics is a male domain, but male students have statistically higher results with regard to stereotypes acceptance. Finally, female

[4] Four participants did not specify their gender.

students have shown a significantly higher mean on the scales of extraversion, agreeableness, neuroticism and openness, while there are no gender differences in conscientiousness and the perception of teacher role. On average, both groups generally agree that their mathematics teacher is a supportive person. Bivariate correlations of variables are shown in Table 1 in the Appendix.

Two hierarchical regression analyses were used to test the contribution of the predictors *mathematics achievement*, *personality*, *mathematics anxiety*, *stereotypes about mathematics* and *perception of teacher role* to the explanation of the criteria of mathematics self-concept in male and female students. The mathematics achievement variable was first entered in the analysis, followed by personality dimensions. Mathematics anxiety was entered next, followed by the result on the scale of stereotypes about mathematics and the perception of teacher role in the final step. The results of the hierarchical regression analyses are shown in Table 2.

The regression analysis explained about 72% of the variance in mathematics self-concept for the female students' sample. Mathematics achievement independently explains approximately 55% of the criterion variance, whereas the remaining variables explain the additional 17% (personality 5.7%, mathematics anxiety 9.8%, stereotypes about mathematics 0%, perception of teacher role 1.9%). In the final step of the analysis, mathematics achievement, conscientiousness, mathematics anxiety and the perception of teacher role have shown to be significant individual predictors of mathematics self-concept in girls. Female students who have higher marks in mathematics, are more conscientious, feel lower mathematics anxiety and assess their teachers' behaviour as supportive have a higher mathematics self-concept.

The second hierarchical regression analysis explained 63% of the variance in mathematics self-concept for the male students' sample. Mathematics achievement explained 44% of the variance, whereas the remaining variables explained additional 19% of the criterion variance (personality 2.1%, mathematics anxiety 9.8%, stereotypes about mathematics 2.5%, perception of teacher role 4.5%). In the final step of the analysis, mathematics achievement, mathematics anxiety, stereotypes about mathematics and the perception of teacher role have shown to be significant individual predictors of mathematics self-concept in male students. In other words, male students who have higher marks in mathematics, lower mathematics anxiety, hold more stereotypes about mathematics as a male domain and who assess their teachers' behaviour as supportive have a higher mathematics self-concept.

This group of variables explained 9% more variance of mathematics self-concept in female students than in male students, mainly due to the different correlation of mathematics achievement and mathematics self-concept for these two samples. Namely, the correlation of mathematics achievement and mathematics self-concept is significantly higher in the female than in the male students' sample ($z_{obs} = 2.03$, $p < 0.05$).

Table 2

*Results of hierarchical regression analyses for the criteria of mathematics self-concept in female and male students (** p < 0.01, * p < 0.05).*

	Mathematics self-concept in female students		Mathematics self-concept in male students	
	β	*p*	B	*p*
Blocks of predictors				
1 – Mathematics achievement	$\Delta R^2 = .545^{**}$, $p = .000$		$\Delta R^2 = .444^{**}$, $p = .000$	
Mathematics achievement	.738**	.000	.666**	.000
2 – Personality	$\Delta R^2 = .057^{**}$, $p = .000$		$\Delta R^2 = .021$, $p = .359$	
Mathematics achievement	.682**	.000	.602**	.000
Extraversion	-.117*	.025	.024	.739
Agreeableness	.079	.124	.014	.840
Conscientiousness	.109	.054	.151	.058
Neuroticism	-.141*	.013	.034	.644
Openness	.014	.784	.007	.915
3 – Mathematics anxiety	$\Delta R^2 = .098^{**}$, $p = .000$		$\Delta R^2 = .098^{**}$, $p = .000$	
Mathematics achievement	.506**	.000	.501**	.000
Extraversion	-.045	.332	-.007	.919
Agreeableness	.082	.070	-.046	.478
Conscientiousness	.111*	.025	.107	.138
Neuroticism	.003	.958	.029	.660
Openness	-.001	.989	.053	.404
Mathematics anxiety	-.393**	.000	-.348**	.000
4 – Stereotypes about mathematics	$\Delta R^2 = .000$, $p = .797$		$\Delta R^2 = .025^{**}$, $p = .005$	
Mathematics achievement	.509**	.000	.496**	.000
Extraversion	-.043	.350	-.020	.758
Agreeableness	.081	.072	-.053	.407
Conscientiousness	.110*	.026	.082	.245
Neuroticism	.002	.973	.011	.866
Openness	.000	.994	.083	.189
Mathematics anxiety	-.394**	.000	-.353**	.000
Stereotypes about mathematics	.011	.797	.162**	.005
5 – Perception of teacher role	$\Delta R^2 = .019^{**}$, $p = .000$		$\Delta R^2 = .045^{**}$, $p = .000$	
Mathematics achievement	.502**	.000	.504**	.000
Extraversion	-.059	.191	-.033	.592
Agreeableness	.030	.510	-.078	.198
Conscientiousness	.117*	.015	.035	.606
Neuroticism	-.012	.816	-.016	.790
Openness	.001	.980	.061	.310
Mathematics anxiety	-.364**	.000	-.312**	.000
Stereotypes about mathematics	-.010	.818	.135*	.013
Perception of teacher role	.148**	.000	.232**	.000
	$R^2 = .718^{**}$, $F = 54.720$, $p = .000$		$R^2 = .633^{**}$, $F = 26.101$, $p = .000$	

Discussion

According to the results of this research, there is no statistically significant difference in the level of mathematics self-concept between male and female students. Such findings are in disagreement with earlier studies which mainly found differences in favour of male students. Marsh et al. (2006) report lower mathematics self-concept in German female students. The same results were obtained on a sample of American elementary and middle school students and on a sample of secondary school students in the USA, Australia and Germany (Kurtz-Costes et al., 2008; Nagy et al., 2010). Our findings point to the fact that neither boys nor girls have the tendency to believe that mathematics is a typically male domain, although boys agree with this statement to a slightly higher extent than girls. Previous study on the same sample has shown that both groups agree that everybody can be good at mathematics (Jugović, Baranović, & Marušić, 2012). These results speak in favour of a gender-egalitarian understanding of the competence necessary for success in mathematics. However, international research indicates that the stereotypes about mathematics as a traditionally male domain persist (e.g. Cvencek, Meltzoff, & Greenwald, 2011; Else-Quest et al., 2010; Guimond & Roussel, 2001; Keller, 2001; Nosek, Banaji, & Greenwald, 2002). Additional research including students of different age groups on a nationally representative sample could clearly show whether there are gender differences in the mathematics self-concept of Croatian students, as well as the dynamics of their development.

The female students from our sample achieve, on average, significantly better marks in mathematics than the male students. Jacobs (1991) and Kurtz-Costes et al. (2008) also report that female students achieve higher marks in mathematics. Our findings correspond with the observation that gender differences regarding mathematics achievement have diminished, disappeared or changed direction in favour of girls since the 1970s and 1980s (Jugović et al., 2012).

The last PISA investigation reports that female students experience higher mathematics anxiety than male students (OECD, 2013). The findings about a higher level of mathematics anxiety in girls correspond with the results obtained by Arambašić et al. (2005). However, several authors report no or negligible gender differences in mathematics anxiety (Hyde et al., 1990; Ma, 1999). Such contradictory results can be the consequence of measuring mathematics anxiety either as a trait, or as a state (Goetz et al., 2013). In our research, like in the one by Arambašić et al. (2005), the average level of mathematics anxiety is low, regardless of the participants' gender. Nevertheless, the fact that girls are more afraid of mathematics, although they achieve better results in it, deserves additional attention. Feingold (1994) and Pollack (1998) have pointed out possible reasons for higher anxiety in girls, stating that girls are generally more anxious than boys during adolescence whereas boys are more reluctant to admit fear due to social pressure.

The results of the hierarchical regression analyses have shown that mathematics achievement explains 55% of variance in mathematics self-concept for female students

and 44% of variance for male students. Such high criterion variance percentages explained by one variable point to a strong interdependence between mathematics self-concept and the mark achieved in mathematics. Such results consistently appear in international research (Kurtz-Costes et al., 2008; Ma & Kishor, 1997; Marsh & Hau, 2004; Marsh et al., 2006, Möller et al., 2009, Puklek Lepuvšček et al., 2013). Similar to our results, other findings obtained on a sample of Croatian students point out that generalised self-efficacy and the perception of perseverance in mathematics are moderately positively correlated to the mathematics mark in students attending the final year of primary school, whereas the perception of incompetence in the area of mathematics shows a moderately negative correlation with this criterion (Čizmić, 2006). In analysing the relationships between mathematics self-concept and success in mathematics in 69 studies, Möller et al. (2009) found that the average correlation between the two variables is 0.43. According to a meta-analysis conducted by Ma and Kishor (1997), the average correlation of mathematics self-concept and mathematics achievement is 0.23 (*SD*=0.16) and it does not differ with regard to participants' gender. Contrary to that, our research has revealed a significantly higher correlation of mathematics mark and mathematics self-concept in the girls' than in the boys' sample. Success in mathematics appears to be a more important determinant of mathematics self-concept in girls than in boys, at least for this sample of Croatian elementary school children. The potentially different role of teacher-generated feedback about one's success in mathematics in the formation of mathematics self-concept for girls vs. boys in Croatian schools needs further examination. This finding could have practical implications for gender-sensitive mathematics teaching, where feedback provided to both boys and girls should be formulated as to enhance their self-concept in this area.

The introduction of personality dimensions in our analysis indicated that personality factors explain an additional 5.7% of criterion variance in girls and a statistically non-significant 2.1% in boys. Conscientiousness, along with the other variables, has a unique contribution to criterion explanation in female students. In male students, there is no personality factor which independently contributes to the prediction of mathematics self-concept. Research conducted by Marsh et al. (2006) on a joint sample of young men and women, also revealed that mathematics self-concept is related to conscientiousness. Puklek Lepuvšček et al. (2013) found a significant correlation of conscientiousness and mathematics self-efficacy. In their study, the self-concept acted as a mediator in the relationship between conscientiousness and achievement in mathematics.

Mathematics anxiety explains somewhat less than an additional 10% of the criterion variance in both gender groups. In other words, this variable equally determines the mathematics self-concept of male and female students and is, including all the other variables, a significant independent predictor in both groups. Čizmić (2006) found that generalised self-efficacy and perseverance in mathematics show a moderately negative correlation with mathematics anxiety, whereas the perception of incompetence in

mathematics is moderately positively correlated with this criterion (see also Meece, Wigfield, & Eccles, 1990). The same author noticed that mathematics anxiety and the perception of personal competence in mathematics partly share common factors and circumstances of development (e.g. earlier success or lack of success, comparison with peers or judgements of others).

In female students, the variable *stereotypes about mathematics* has not at all contributed to the explanation of variance in mathematics self-concept, whereas in male students it has increased the percentage of totally explained variance by 2.5%. It seems that endorsing stereotypes has contributed somewhat to the development of mathematics self-concept in male students, whereas it has had neither positive nor negative consequence on female students. Results which are in line with these were obtained by Kurtz-Costes et al. (2008). In boys, mathematics self-concept was related to their belief that there are traditional stereotypes among adults about male superiority in mathematics and to their personal belief in such stereotypes. In girls, no significant correlation of stereotypes and mathematics self-concept was observed (Kurtz-Costes et al., 2008). The positive effect of stereotypes on male students' self-concept and the lack of negative effect on female students' self-concept is well explained by social status theory, based on Tajfel's social identity theory. According to this theory, it is more probable that male students, in order to keep a positive self-image, will tend to accept stereotypes about mathematics, i.e. will assess their own group as more positive than the outgroup (female students' group). For the same adaptive reason, girls might, in order to protect their self-esteem, resist accepting stereotypes which are not in their favour (Kurtz-Costes et al., 2008). For those students who internalise stereotypes about mathematics or believe that adults believe in stereotypes, such beliefs can only have a self-enhancing effect (Kurtz-Costes et al., 2008). Their belief that they are capable of meeting mathematical demands makes them more inclined to investing effort and resources, which will lead to the achievement of their goal and to developing a more positive self-image.

Finally, students' perception of teacher role was entered in the analysis in the last block. This variable has a statistically significant independent contribution to prediction in both samples. In girls, it explains an additional 1.9%, and in boys, 4.5% of the criterion variance of mathematics self-concept. Even though this is a modest contribution, especially in the case of girls, the perception of teacher support is obviously one of the determinants of the development of students' self-image in mathematics. These findings are in line with the observations about the role played by teacher-student interaction in educational outcomes at the affective, social and academic levels (Roeser et al., 2000; Roorda et al., 2011; Wubbels & Brekelmans, 2006). Hughes (2011) and Puklek Lepuvšček et al. (2013) have found that some characteristics of the teacher-student relationship shape students' feeling of mathematics self-efficacy. Moreover, Vandecandelaere, Speybroeck, Vanlaar, De Fraine, and Van Damme (2012) report that teacher behaviour affects the aspect of enjoyment in mathematics. Although

no connection with self-concept was found, this indirectly supports our conclusion that teacher behaviour will partly determine the way both male and female students will approach mathematics.

In future studies it would be useful to look into other factors that can determine mathematics self-concept, such as the *Big-fish-little-pond* effect[5], students' sociogram status, the ratio of positive and negative affectivity in students, optimism, and other. Besides, it would be interesting to investigate whether the results obtained in this study differ with regard to age, especially in younger students whose mathematics self-concept is still developing.

Since mathematics is one of the most important school subjects on which enrolment in secondary school or at university very frequently depends, it is important to help children develop the belief in their own competence to master mathematical tasks. Understanding the complexity of the construct of self-concept and of the factors determining it is a step towards planning and implementing educational interventions whose aim is to strengthen student beliefs about their own mathematical ability. The findings of this and similar studies can contribute to evidence-based planning and implementation of gender-universal and gender-specific interventions for the enhancement of mathematics self-concept.

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[5] The effect according to which academic self-concept depends not only on the abilities of the student him/herself but on the average level of the abilities of the peers in the class which the student attends. Students of the same cognitive abilities will have a higher academic self-concept in an educational context in which the average cognitive abilities are lower (Marsh, 2005).

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Appendix

Table 1

*Bivariate correlations of the variables used in investigating the determinants of mathematics self-concept (female students' results are above the diagonal, whereas male students' results are below the diagonal; ** p< 0.01; * p< 0.05).*

	Mathematics self-concept	Mathematics achievement	Extraversion	Agreeableness	Conscientious ness	Neuroticism	Openness	Mathematics anxiety	Stereotypes about mathematics	Perception of teacher role
Mathematics self-concept	1	.755**	.115	.151*	.435**	-.292**	.198**	-.658**	-.267**	.261**
Mathematics achievement	.659**	1	.109	.004	.344**	-.158**	.231**	-.503**	-.314**	.093
Extraversion	.194**	.252**	1	.085	.242**	-.415**	.276**	-.071	-.123*	.124*
Agreeableness	.146*	.110	.221**	1	.362**	-.354**	.132*	-.079	-.010	.250**
Conscientiousness	.390**	.424**	.365**	.324**	1	-.421**	.278**	-.282**	-.117	.139*
Neuroticism	-.162*	-.238**	-.359**	-.415**	-.336**	1	-.150*	.332**	.196**	-.112
Openness	.117	.098	.337**	.254**	.293**	-.167*	1	-.123	-.084	.044
Mathematics anxiety	-.529**	-.359**	-.132	-.171*	-.277**	.198**	-.029	1	.298**	-.262**
Stereotypes about mathematics	.228**	.096	.086	.018	.109	.078	-.069	-.016	1	.004
Perception of teacher role	.382**	.106	.150*	.186**	.251**	-.072	.214**	-.245**	.135*	1

Determinante matematičkog samopoimanja: Analiza rodnih univerzalnosti i specifičnosti[1]

Sažetak

Cilj istraživanja bio je razmotriti ulogu koju u objašnjenju matematičkog samopoimanja, osim uspjeha u matematici, imaju osobine ličnosti, matematička anksioznost, stereotipi o matematici kao muškom području i percepcija uloge i ponašanja nastavnika matematike. Istraživanje je provedeno na uzorku od 511 učenika 8. razreda iz 36 osnovnih škola u Zagrebu i Zagrebačkoj županiji. Analiza doprinosa spomenutih prediktora napravljena je na rodno odijeljenim uzorcima. Hijerarhijskim regresijskim analizama utvrđeni su pojedinačni doprinosi varijabli i ukupni doprinos prediktora objašnjenju varijance matematičkog samopoimanja učenika (R = 0.63) i učenica (R = 0.72). Uspjeh u matematici najsnažnija je odrednica matematičkog samopoimanja obiju rodnih skupina. Ličnost, točnije, savjesnost rodno je specifična determinanta koja doprinosi objašnjenju varijance matematičkog samopoimanja učenica, ali ne i učenika. Obrnuto vrijedi za stereotipe o matematici koji su se pokazali rodno specifičnom determinantom samopoimanja učenika. Strah od matematike, percepcija uloge i ponašanja nastavnika rodno su univerzalne odrednice. Rezultati mogu doprinijeti utemeljenom planiranju i primjeni univerzalnih i specifičnih intervencija za poboljšanje matematičkog samopoimanja učenica i učenika.

Ključne riječi: *ličnost; matematička slika o sebi; rodne razlike; strah od matematike.*

Uvod

Uvjerenja o osobnim karakteristikama i sposobnostima koje osoba stvara na temelju vlastitih iskustava i usporedbe s drugima uvjetuju njezin odnos prema određenom zadatku i uspjeh u njemu. Osoba koja se osjeća kompetentnom postići će više od osobe istih sposobnosti, ali niže percipirane kompetencije za ovladavanje zadatkom (Marsh, 2005).

[1] Rad je prezentiran na konferenciji XIX. Dani psihologije u Zadru (29. – 31. svibnja, 2014.).

U literaturi se to uvjerenje naziva *samopoimanjem*, tj. doživljajem koji osoba ima o sebi (Shavelson, Hubner i Stanton, 1976). Samopoimanje je multidimenzionalni konstrukt sastavljen od relativno nezavisnih koncepata koji reprezentiraju samopoimanje osobe u različitim domenama funkcioniranja (Marsh, Trautwein, Lüdtke, Köller i Baumert, 2006).

U predviđanju obrazovnih ishoda najveću prediktivnu snagu pokazalo je akademsko samopoimanje (Marsh i Craven, 2006). Istraživanja su pokazala da je ono povezano s pozitivnim stavovima prema školi, interesom za određeni predmet, odabirom odgovarajućih strategija učenja, ustrajnošću u radu na različitim akademskim zadacima i obrazovnim postignućima i aspiracijama (Craven i Marsh, 2008; Green, Liem, Martin, Colmar, Marsh i McInerney, 2012; Marsh, Trautwein, Lüdtke, Köller i Baumert, 2005; Möller, Pohlmann, Köller i Marsh, 2009).

U središtu ovog rada jest matematičko samopoimanje kao dio akademskog samopoimanja. Istraživanja pokazuju da uvjerenje o matematičkoj sposobnosti ima ključnu ulogu u odabiru i održavanju adaptivnog ponašanja pri učenju matematike (Trautwein, Lüdtke, Roberts, Schnyder i Niggli, 2009), odabiru studija u području znanosti, tehnologije ili matematike i uspjehu pri upisu u visoko obrazovanje (Parker, Marsh, Ciarrochi, Marshall i Abduljabbar, 2014).

Kakvu će matematičku sliku o sebi učenici izgraditi, uvelike ovisi o njihovu uspjehu u matematici. Brojna istraživanja potvrđuju povezanost matematičkog samopoimanja i uspjeha u matematici (npr. Kurtz-Costes, Rowley, Harris-Britt i Woods, 2008; Ma i Kishor, 1997; Marsh i sur., 2006). Ta je povezanost utvrđena i međukulturalno, na podacima dobivenim PISA[2] istraživanjem u 26 zemalja (Marsh i Hau, 2004). Uzajamni utjecaji samopoimanja i postignuća dolaze do izražaja u modelu referentnog okvira (Marsh i Hau, 2004), čija je univerzalnost potvrđena neovisno o spolu, dobi ili zemlji porijekla sudionika istraživanja (Möller i sur., 2009). Kad svoj uspjeh u određenom predmetu uspoređuju s uspjehom vršnjaka u razredu, učenici se koriste eksternalnim okvir za usporedbu. Ako se u toj usporedbi procijene uspješnima, učenici će imati dobro samopoimanje u tom predmetu. Internalni okvir za usporedbu pretpostavlja da učenici svoj uspjeh u, primjerice matematici, uspoređuju s uspjehom u drugim školskim predmetima. Ako je njihov uspjeh u matematici bolji od uspjeha u drugim predmetima, učenici će imati pozitivno matematičko samopoimanje, čak i ako nisu osobito uspješni u matematici u usporedbi s drugim učenicima.

Poput veze akademskog samopoimanja i uspjeha (Craven i Marsh, 2008), i povezanost osobina ličnosti, ponajprije savjesnosti i otvorenosti, s akademskim uspjehom dobro je dokumentirana (Poropat, 2009). Međutim, ta dva sustava ličnosti i različiti vidovi akademskog ponašanja rijetko su razmatrani zajedno, dijelom zato što pripadaju različitim istraživačkim tradicijama. Dimenzionalni pristup unutar psihologije ličnosti uvjerenja o vlastitoj kompetenciji smatra karakterističnim

[2] *Programme for International Student Assessment*, OECD

adaptacijama na okolinu koje su u velikoj mjeri manifestacije savjesnosti u specifičnom, akademskom kontekstu (McCrae i Costa, 1999), pa savjesnost predviđa akademski uspjeh putem uvjerenja o vlastitoj kompetenciji. Tradicija unutar obrazovnih istraživanja smatra da akademsko samopoimanje i samodjelotvornost[3] predviđaju trud uložen u učenje i uspjeh neovisno o osobinama ličnosti. U području istraživanja učenja i uspjeha iz matematike oba modela dobivaju određenu empirijsku potporu. Savjesnost i vjerovanja o vlastitoj kompetentnosti neovisno predviđaju trud uložen u učenje matematike (Trautwein i sur., 2009). S uspjehom u matematici savjesnost je neizravno povezana putem matematičke samodjelotvornosti (Puklek Lepuvšček, Zupančič i Sočan, 2013). Razmjerno malobrojni istraživački podaci o odnosu ličnosti i samopoimanja upućuju na povezanost pojedinih tipova akademskog samopoimanja sa savjesnošću i otvorenošću (Marsh i sur., 2006).

Istraživanja o matematičkoj anksioznosti također imaju važnu ulogu u razumijevanju učeničkih postignuća i iskustava s tim školskim predmetom. Metaanalize upućuju na negativnu povezanost matematičke anksioznosti i uspjeha u matematici (Hembree, 1990; Ma, 1999). Valja napomenuti da posljednje PISA istraživanje pokazuje da djevojčice doživljavaju značajno više anksioznosti i drugih negativnih emocija vezanih uz matematiku od dječaka u 52 od 65 ispitanih zemalja, uključujući i Hrvatsku (OECD, 2013). No dio istraživanja ne nalazi rodne razlike u matematičkoj anksioznosti ili navodi da su one vrlo male (Hyde, Fennema, Ryan, Frost i Hopp, 1990; Ma, 1999). Jedan od razloga proturječnih rezultata može biti i način mjerenja matematičke anksioznosti. Naime, djevojčice iskazuju veću anksioznost mjerenu kao stabilnu osobinu, a u situacijski uvjetovanom strahu tijekom sata matematike ili pri pisanju testa nisu utvrđene rodne razlike (Goetz, Bieg, Lüdtke, Pekrun i Hall, 2013).

Uz internalna svojstva samopoimanje ovisi i o okolini, kao i o iskustvima učenika (Marsh i sur., 2006). Pritom se među najvažnijim kontekstualnim faktorima ističe odnos učenika i učitelja koji ima malu, ali značajnu ulogu u učeničkim postignućima, a osobito u afektivnim i motivacijskim ishodima obrazovanja (Roorda, Koomen, Spilt i Oort, 2011; Wubbels i Brekelmans, 2006). Učenici koji doživljavaju svoje učitelje kao brižne i podržavajuće motiviraniji su za učenje i uspješniji u svom socijalnom, emocionalnom i akademskom djelovanju (Roeser, Eccles i Sameroff, 2000). Iako su podaci o ulozi učitelja u oblikovanju akademskog samopoimanja prilično malobrojni, pojedini nalazi upućuju na to da su neke dimenzije odnosa učitelja prema učenicima povezane s većom matematičkom samodjelotvornošću učenika (Hughes, 2011; Puklek Lepuvšček i sur., 2013).

Istraživanja dobro dokumentiraju rodnu dimenziju matematičkog samopoimanja. U metaanalizi koja uključuje reprezentativne nacionalne uzorke učenika iz šezdesetak

[3] Samopoimanje reprezentira opću sliku o sebi u određenim područjima djelovanja, a samodjelotvornost predstavlja očekivanje i uvjerenja osobe o vlastitoj uspješnosti u konkretnim situacijama (Bong i Skaalvik, 2003). Iako donekle različita, oba konstrukta predviđaju akademsku motivaciju, emocije i uspjeh.

zemalja, Else-Quest, Hyde i Linn (2010) nalaze konzistentno više matematičko samopoimanje dječaka. Nagy, Watt, Eccles, Trautwein i Lüdtke (2010) primjećuju da su se razlike u matematičkom samopoimanju u korist dječaka dosljedno održavale tijekom srednje škole u uzorcima učenika iz SAD-a, Australije i Njemačke.

Cilj ovog rada je razmotriti ulogu koju u objašnjenju matematičkog samopoimanja učenika i učenica, uz ocjenu iz matematike, imaju osobine ličnosti, strah od matematike, stereotipi o matematici kao tradicionalno muškom području (u daljnjem tekstu: stereotipi o matematici) i percepcija uloge i ponašanja nastavnika matematike (u daljnjem tekstu: percepcija uloge nastavnika). Karakteristike učenika (ličnost i matematička anksioznost), kao i njihova percepcija okruženja u kojem se odvija učenje i poučavanje matematike (prihvaćanje stereotipa o matematici i percepcija uloge nastavnika) uključene su kako bi se analizirao potencijalni doprinos koji te varijable, uz ocjenu iz matematike, mogu imati u objašnjenju fenomena matematičkog samopoimanja.

Metodologija

Sudionici i postupak

Sudionici istraživanja bili su učenici osmih razreda iz 36 osnovnih škola u Zagrebu i Zagrebačkoj županiji. Uzorak učenika bio je reprezentativan, stratificiran prema veličini i ruralno-urbanoj lociranosti škole. Terenski dio istraživanja proveden je u dvije vremenske točke. Prvo je primijenjen upitnik koji je ispitivao elemente matematičke kompetencije učenika. Dva tjedna poslije primijenjen je upitnik u sklopu kojeg su učenici davali samoprocjene ličnosti i matematičkog samopoimanja. Ovaj rad temelji se na podacima prikupljenim na uzorku učenika koji su sudjelovali u obje točke istraživanja (N = 511, 56% učenice). Ispitivanje se u oba navrata provodilo grupno u učionici, u trajanju od 45 minuta. Bile su osigurane anonimnost sudionika i roditeljske suglasnosti, a podaci iz dviju točki istraživanja povezani su na temelju posebnih šifri.

Instrumenti

Matematičko samopoimanje ispitano je hrvatskom inačicom ljestvice matematičkog pojma o sebi iz *Self-Description Questionnaire – II* (Marsh, 1990), koja je oblikovana za mjerenje samopoimanja kod mlađih adolescenata. Učenici su zamoljeni da odgovore na 10 jednostavnih tvrdnji (npr. „Matematika je jedan od predmeta koji mi najbolje idu.“), dajući procjene na skali od 1 („uopće me ne opisuje“) do 6 („vrlo dobro me opisuje“). Viši rezultat na skali upućuje na veću razinu matematičkog samopoimanja. Pouzdanost skale na ovom uzorku iznosi α=0,928.

Varijabla *uspjeh iz matematike* kreirana je kao prosjek školskih ocjena iz matematike s polugodišta i kraja sedmog , kao i s polugodišta osmog razreda (α=0,946). Izveden je prosjek kako bi se dobila stabilnija procjena uspjeha u matematici.

Ličnost je mjerena hrvatskim prijevodom BFI upitnika za djecu (John i Srivastava, 1999). Upitnik mjeri osobine petfaktorskog modela ličnosti; ekstraverziju (α=0,733), ugodnost (α=0,712), savjesnost (α=0,767), neuroticizam (α=0,730) i otvorenost

(α=0,711). Sastoji se od 44 tvrdnje u kojima su navedene osobine ljudi, a zadatak sudionika je slaganje s tvrdnjom (npr. „Sebe vidim kao osobu koja ustraje sve dok ne završi zadatak") izraziti na skali Likertova tipa od 1 („uopće se ne slažem") do 5 („u potpunosti se slažem").

Strah od matematike ispitan je skalom koja je, uz dopuštenje autorica, adaptirana po uzoru na Ljestvicu za ispitivanje straha od matematike (Arambašić, Vlahović-Štetić i Severinac, 2005). Skala je prvotno konstruirana za upotrebu na srednjoškolskom uzorku, pa je za primjenu s učenicima osnovnih škola dio tvrdnji izostavljen (α= 0,916). Sadrži 16 situacija vezanih uz matematiku u kojima se učenici mogu naći (npr. „Kad pišem važnu pismenu provjeru iz matematike,…"). Zadatak sudionika je bio da na skali od 1 („nisam uznemiren/a") do 4 ("strašno sam uznemiren/a") iskažu koliku im uznemirenost izaziva pojedina situacija. Viši rezultat na skali ukazuje na snažniji strah od matematike.

Skala stereotipa o matematici kao muškom području konstruirana je za potrebe ovog istraživanja (α=0,901). Sastoji se od 7 tvrdnji koje ispituju slaganje s rečenicama koje matematiku opisuju kao tradicionalno muško područje, poput „Djevojčice se često moraju truditi više od dječaka da bi postigle isti uspjeh iz matematike." Slaganje s tvrdnjama označavano je na skali od 4 stupnja pri čemu 1 znači "uopće se ne slažem", a 4 "u potpunosti se slažem". Metodom glavnih komponenti utvrđeno je da je za interkorelacije među česticama odgovorna jedna komponenta koja objašnjava 62,96 % varijance rezultata. Viši rezultat na skali sugerira snažnije prihvaćanje stereotipa o matematici.

Skala uvjerenja o ulozi i ponašanju nastavnika matematike prilagođena je za potrebe ovog istraživanja (α=0,920) prema istoimenoj subskali iz upitnika *Mathematics-related belief questionnaire* (Op't Eynde i De Corte, 2004). Skraćena varijanta skale sastoji se od 9 čestica koje opisuju ponašanje nastavnika matematike (npr. „Naš nastavnik misli da su pogreške koje činimo korisne sve dok iz njih učimo."), a učenici su slaganje s tvrdnjama obilježavali na skali od 1 („uopće se ne slažem") do 4 („u potpunosti se slažem"). Metodom glavnih komponenti dobiveno je da je u pozadini interkorelacija među česticama jedna komponenta koja objašnjava 61,42% varijance rezultata. Viši rezultat upućuje na izraženiju percepciju podržavajućeg ponašanja nastavnika matematike.

Rezultati

Zbog uočenih rodnih specifičnosti, ali i iskustava drugih istraživača koji navode da je odvojena analiza samopoimanja učenika i učenica informativnija (Ma i Kishor, 1997), analize podataka provedene su na rodno odijeljenim uzorcima. Tablica 1 prikazuje aritmetičke sredine i standardne devijacije rezultata učenica (*N*=284) i učenika (*N*=223)[4], kao i rezultate t-testova kojima su ispitane rodne razlike na relevantnim varijablama.

[4] Četiri osobe nisu naznačile spol.

Tablica 1.

Prosječni rezultati koje na skali matematičkog samopoimanja ostvaruju učenice i učenici gotovo su identični. U oba uzorka radi se o umjerenoj razini matematičkog samopoimanja. S druge strane, učenici i učenice imaju različite prosjeke na nizu drugih analiziranih varijabli. Učenice ostvaruju statistički značajno više rezultate na varijabli uspjeha iz matematike i straha od matematike. Iako u prosjeku postižu vrlo dobar uspjeh iz matematike te ostvaruju bolje školske rezultate od dječaka, djevojčice se matematike statistički značajno više plaše. Ipak, valja reći da razlika u matematičkoj anksioznosti nije velika te da i učenice i učenici navode da u prosjeku osjećaju tek malu uznemirenost vezanu uz matematiku. Nadalje, iako se u prosjeku dječaci i djevojčice uglavnom ne slažu s tvrdnjama o tome da je matematika muško područje, učenici na skali pristajanja uz stereotipe ipak ostvaruju statistički značajno više rezultate. Na kraju, učenice imaju statistički značajno viši prosjek na skalama ekstraverzije, ugodnosti, neuroticizma i otvorenosti, a rodnih razlika u osobini savjesnosti i percepciji uloge nastavnika nema. Obje se skupine u prosjeku uglavnom slažu s tim da je njihov nastavnik matematike podržavajuća osoba. Bivarijatne korelacije varijabli prikazane su u tablici 1 u Prilogu.

Dvjema hijerarhijskim regresijskim analizama ispitan je doprinos prediktora *uspjeh iz matematike*, *ličnost*, *strah od matematike*, *stereotipi o matematici* i *percepcija uloge nastavnika* objašnjenju kriterija matematičkog samopoimanja učenica i matematičkog samopoimanja učenika. U analizu je najprije uključena varijabla uspjeh iz matematike jer je cilj ovog rada provjeriti objašnjavaju li ostali blokovi varijabli dodatni dio varijance koju ne objašnjava ocjena. Nakon toga je uključen blok dimenzija ličnosti. Zatim su predikciji pridružene varijable strah od matematike (u trećem koraku) i rezultat na skali stereotipa o matematici (u četvrtom koraku). U posljednjem je bloku u analizu uvrštena i percepcija uloge nastavnika. Rezultati hijerarhijskih regresijskih analiza prikazani su u tablici 2.

Tablica 2.

Regresijskom analizom objašnjeno je oko 72 % varijance matematičkog pojma o sebi kod učenica iz našeg uzorka. Uspjeh iz matematike samostalno objašnjava oko 55 % varijance kriterija, a ostale varijable dodatnih 17 % (ličnost 5,7 %, strah od matematike 9,8 %, stereotipi o matematici 0 % i percepcija uloge nastavnika 1,9 %). Kao značajni pojedinačni prediktori matematičkog samopoimanja kod djevojčica u posljednjem koraku analize pokazali su se uspjeh iz matematike, savjesnost, strah od matematike i percepcija nastavničke uloge. Viši matematički pojam o sebi imaju učenice koje postižu bolje ocjene iz matematike, savjesnije su, osjećaju manju matematičku anksioznost i one koje ponašanje svojih nastavnika ocjenjuju podržavajućim.

Drugom hijerarhijskom regresijskom analizom ukupno je objašnjeno 63 % varijance matematičkog pojma o sebi na uzorku učenika. Uspjeh iz matematike objasnio je 44 % varijance, a ostalim je varijablama eksplicirano dodatnih 19 % varijance

kriterija (ličnošću 2,1 %, strahom od matematike 9,8 %, stereotipima o matematici 2,5 % i percepcijom uloge nastavnika 4,5 %). U posljednjem koraku analize značajni prediktori matematičkog samopoimanja kod učenika bili su uspjeh iz matematike, strah od matematike, stereotipi o matematici i percepcija nastavničke uloge. Bolje matematičko samopoimanje imaju učenici boljeg uspjeha iz matematike, manjeg straha od matematike, izraženijih uvjerenja o tome kako je matematika stereotipno muško područje i oni koji smatraju da se njihovi nastavnici matematike ponašaju podržavajuće.

Ovim skupom varijabli objašnjeno je 9 % više varijance matematičkog samopoimanja kod učenica nego kod učenika, i to uglavnom zbog različite povezanosti uspjeha iz matematike i matematičkog samopoimanja za ta dva uzorka. Naime, utvrđeno je da je korelacija uspjeha iz matematike i matematičkog samopoimanja statistički značajno veća na uzorku učenica nego učenika (z_{obs}= 2,03, $p < 0,05$).

Rasprava

Prema rezultatima ovog istraživanja nema statistički značajne razlike u razini matematičkog samopoimanja učenika i učenica. Takav nalaz u nesuglasju je s prijašnjim istraživanjima koja su uglavnom pokazivala razlike u korist dječaka. Marsh i suradnici (2006) na velikom su uzorku starijih njemačkih adolescenata zabilježili niže matematičko samopoimanje kod djevojaka. Isti je nalaz proizašao i iz podataka prikupljenih na uzorku američkih učenika osnovnoškolske dobi (Kurtz-Costes i sur., 2008) i uzorku srednjoškolaca iz SAD-a, Australije i Njemačke (Nagy i sur., 2010). Naši nalazi ukazuju na to da ni djevojčice ni dječaci nisu skloni uvjerenju da je matematika tipično muško područje, premda se dječaci nešto više slažu s tom tvrdnjom. Podaci prikupljeni na istom uzorku pokazuju i da se obje skupine slažu s tim da svatko može biti dobar u matematici (Jugović, Baranović i Marušić, 2012). To govori u prilog rodno egalitarnog poimanja kompetencije potrebne za uspjeh u matematici. Međutim, međunarodna istraživanja ukazuju na održavanje stereotipa o matematici kao tradicionalno muškom području (npr. Cvencek, Meltzoff i Greenwald, 2011; Else-Quest i sur., 2010; Guimond i Roussel, 2001; Keller, 2001; Nosek, Banaji i Greenwald, 2002). Dodatna istraživanja koja bi uključivala učenike različitog uzrasta na nacionalno reprezentativnom uzorku mogla bi jasno pokazati postoje li rodne razlike u matematičkom samopoimanju naših učenika i kakva je njihova razvojna dinamika.

Učenice iz našeg uzorka u prosjeku ostvaruju značajno bolje ocjene iz matematike od učenika. O tome da su učenice, sudeći po ocjenama, uspješnije u matematici, izvještavaju i druga istraživanja (npr. Jacobs, 1991; Kurtz-Costes i sur., 2008). Naš nalaz odgovara zapažanju da se rodne razlike u uspješnosti u matematici od 1970.-ih i 1980.-ih godina smanjuju, nestaju ili mijenjaju smjer u korist djevojaka (Jugović i sur., 2012).

Posljednje PISA istraživanje ukazuje na to da učenice osjećaju više anksioznosti vezane uz matematiku od učenika (OECD, 2013). Nalaz o izraženijem strahu od

matematike kod učenica odgovara i rezultatima Arambašić i suradnica (2005). Neka pak istraživanja pokazuju da rodnih razlika u matematičkoj anksioznosti nema ili da su zanemarive (Hyde i sur., 1990; Ma, 1999). Takvi kontradiktorni nalazi mogu biti posljedica različitog pristupa mjerenju matematičke anksioznosti kao crte ili stanja (Goetz i sur., 2013). U našem, kao i u istraživanju Arambašić i suradnica (2005), strah od matematike u prosjeku je slabo izražen, neovisno o rodu sudionika. Ipak, indikacija o tome da se učenice više boje matematike iako u njoj postižu bolje rezultate, zaslužuje dodatnu pažnju. Na moguće razloge većeg straha kod djevojaka ukazali su Feingold (1994) i Pollack (1998) navodeći da su djevojčice u pubertetu generalno anksioznije nego dječaci, a dječaci, zbog društvenog pritiska, manje skloni priznati svoj strah.

Rezultati hijerarhijskih regresijskih analiza pokazali su da matematički uspjeh objašnjava 55 % varijance matematičkog samopoimanja kod učenica i 44 % te varijance kod učenika. Tako veliki postotci varijance kriterija objašnjeni jednom varijablom ukazuju na snažnu međuovisnost matematičkog pojma o sebi i ocjene iz matematike. Takvi rezultati konzistentno se pojavljuju u međunarodnim istraživanjima (Kurtz-Costes i sur., 2008; Ma i Kishor, 1997; Marsh i Hau, 2004; Marsh i sur., 2006, Möller i sur., 2009, Puklek Lepuvšček i sur., 2013). U skladu s našima, i drugi podaci dobiveni na uzorku hrvatskih učenika upućuju na to da su generalizirana samodjelotvornost i percepcija ustrajnosti u području matematike umjereno pozitivno povezane s ocjenama iz matematike učenika završnih razreda osnovne škole, a percepcija nekompetentnosti u području matematike umjereno je negativno korelirana s kriterijem (Čizmić, 2006). Möller i suradnici (2009), analizirajući veze matematičkog samopoimanja i uspjeha u matematici iz 69 studija, zaključuju da je prosječna korelacija između tih dviju varijabli 0,43. Prema metaanalizi Ma i Kishora (1997), prosječna korelacija matematičkog samopoimanja i matematičkog postignuća iznosi 0,23 (*SD* = 0,16). Potonje istraživanje navodi da se povezanost matematičkog pojma o sebi i uspjeha u matematici ne razlikuje u ovisnosti o rodu sudionika. Nasuprot tome, uspjeh iz matematike i matematičko samopoimanje u značajno su većoj korelaciji kod učenica nego kod učenika iz našeg uzorka. Čini se, stoga, da je uspjeh iz matematike važnija determinanta matematičkog samopoimanja djevojaka nego dječaka, barem u ovom uzorku hrvatskih osnovnoškolaca. Kako bi se razjasnila potencijalno različita uloga koju učiteljske povratne informacije o uspjehu u matematici mogu imati u formiranju matematičkog samopoimanja djevojaka, odnosno dječaka, potrebna su dodatna istraživanja. Nalazi tih istraživanja mogli bi imati praktične implikacije za rodno osjetljivo poučavanje matematike, gdje bi povratna informacija i za djevojčice i za dječake trebala biti oblikovana tako da osnažuje njihovo matematičko samopoimanje.

Uvođenjem dimenzija ličnosti u analizu, ustanovljeno je da osobine ličnosti kod djevojaka ekspliciraju dodatnih 5,7 %, a kod dječaka statistički neznačajnih 2,1 % varijance kriterija. Savjesnost učenica, uza sve druge varijable, ima jedinstven doprinos objašnjenju kriterija. Kod učenika nema faktora ličnosti koji neovisno doprinose predikciji matematičkog samopoimanja. U istraživanju Marsha i suradnika (2006)

na objedinjenom uzorku mladića i djevojaka također se pokazalo da je matematički pojam o sebi najsnažnije povezan sa savjesnošću. Puklek Lepuvšček i suradnici (2013) dobivaju značajnu povezanost savjesnosti i matematičke samodjelotvornosti te utvrđuju da varijabla slike o sebi ima posredujuću ulogu u vezi savjesnosti i uspjeha u matematici.

Strahom od matematike objašnjeno je nešto manje od dodatnih 10 % varijance kriterija kod obje rodne skupine. Dakle, ta varijabla u jednakoj mjeri determinira matematičko samopoimanje učenika i učenica te je za obje skupine značajan samostalni prediktor, i uz sve ostale varijable. Čizmić (2006) zaključuje da su generalizirana samodjelotvornost i ustrajnost u području matematike u umjereno negativnoj korelaciji sa strahom od matematike, a percepcija nekompetentnosti u području matematike umjereno je pozitivno povezana s tim kriterijem (vidjeti, također, Meece, Wigfield i Eccles, 1990). Autorica primjećuje da strah od matematike i percepcija osobne kompetentnosti u području matematike imaju dijelom zajedničke činitelje i okolnosti razvoja (npr. prijašnji uspjesi ili neuspjesi, usporedba s vršnjacima, prosudbe drugih).

Varijabla stereotipi o matematici kod učenica nije nimalo doprinijela objašnjenju varijance matematičkog samopoimanja, a kod učenika je postotak sveukupno objašnjene varijance povećala za 2,5 % te se do kraja analize održala kao značajan prediktor. Čini se da vjerovanje u stereotipe učenicima blago doprinosi razvoju matematičkog samopoimanja, a učenicama ne doprinosi, ali ni ne škodi. Jednake rezultate dobil su Kurtz-Costes i suradnici (2008). Matematičko samopoimanje dječaka bilo je povezano s njihovim uvjerenjem u to da među odraslima vladaju tradicionalni stereotipi o muškoj matematičkoj superiornosti, kao i osobnim vjerovanjem u takve stereotipe. Kod djevojčica nije utvrđena značajna povezanost stereotipa i matematičkog samopoimanja (Kurtz-Costes i sur., 2008). Pozitivan efekt stereotipa na samopoimanje učenika, ali ne i njihov negativan efekt na samopoimanje učenica, dobro pojašnjava teorija socijalnog statusa, nastala na temeljima Tajfelove teorije socijalnog identiteta. Prema toj teoriji, vjerojatnije je da će učenici, kako bi zadržali pozitivnu sliku o sebi, biti skloniji priklanjanju stereotipima o matematici, tj. procjenjivati svoju grupu pozitivnijom od vanjske grupe (učenice). Iz istog adaptivnog razloga, kako bi zaštitile svoje samopoštovanje, djevojke mogu pružati otpor usvajanju stereotipa koji im ne idu u prilog (Kurtz-Costes i sur., 2008). Za učenike koji internaliziraju stereotipe o matematici i one koji smatraju da odrasli vjeruju u taj stereotip, takva uvjerenja mogu imati samopoboljšavajući učinak (Kurtz-Costes i sur., 2008). Vjerovanje da su sposobni udovoljiti matematičkim zahtjevima čini ih sklonijima ulagati trud i resurse, što vodi do toga da postižu svoj cilj i grade pozitivniju sliku o sebi.

Na kraju, u posljednjem je bloku varijabli u analizu uvrštena i učenička percepcija uloge nastavnika. Ta varijabla ima statistički značajan samostalni doprinos predikciji u oba uzorka. Kod djevojaka ona objašnjava dodatnih 1,9 %, a kod dječaka 4,5 % varijance kriterija matematičkog samopoimanja. Makar se radi o skromnom doprinosu,

posebno u slučaju djevojčica, očito je da je percepcija nastavničke podrške jedna od determinanti razvoja učeničkog pojma o sebi u području matematike. Taj je pokazatelj u skladu sa zapažanjima o ulozi koju interakcija nastavnik – učenik ima na obrazovne ishode na afektivnom, socijalnom i akademskom planu (Roeser i sur., 2000; Roorda i sur., 2011; Wubbels i Brekelmans, 2006). Hughes (2011), Puklek Lepuvšček i suradnici (2013) utvrđuju da neke karakteristike odnosa nastavnika i učenika oblikuju učenički osjećaj matematičke samodjelotvornosti. Također, Vandecandelaere, Speybroeck, Vanlaar, De Fraine i Van Damme (2012) zaključuju da ponašanje učitelja djeluje na aspekt uživanja u matematici. Iako nije utvrđena veza s matematičkim samopoimanjem kako je operacionalizirano u tom istraživanju, ovim se indirektno podupire naš zaključak da način učiteljskog ponašanja dijelom determinira to kako će učenice i učenici pristupati matematici.

U budućim istraživanjima bilo bi korisno razmotriti i druge faktore koji mogu determinirati matematičko samopoimanje, poput efekta *Big-fish-little-pond*[5], sociogramskog statusa učenika, omjera pozitivne i negativne afektivnosti učenika, optimizma itd. Ujedno bi bilo zanimljivo vidjeti razlikuju li se ti nalazi ovisno o dobi sudionika, posebno kod mlađih uzrasta čiji je matematički pojam o sebi tek u formiranju.

Kako je matematika jedan od najvažnijih školskih predmeta o kojem često ovisi upis u željenu srednju školu ili na fakultet, važno je pomoći djeci da izgrade uvjerenje o vlastitoj kompetentnosti za savladavanje matematičkih zahtjeva. Razumijevanje složenosti konstrukta matematičkog samopoimanja i faktora koji ga determiniraju korak je u planiranju i provedbi obrazovnih intervencija čiji je cilj jačanje učeničkih uvjerenja u vlastitu matematičku sposobnost. Nalazi ovog i sličnih istraživanja mogu doprinijeti utemeljenom planiranju i primjeni rodno univerzalnih i rodno specifičnih intervencija za unapređenje matematičke slike o sebi.

[5] Efekt prema kojem akademsko samopoimanje, osim o sposobnosti samog učenika, ovisi i o prosječnoj razini sposobnosti razreda u kojem se učenik nalazi. Učenici istih kognitivnih sposobnosti imat će više akademsko samopoimanje u obrazovnom kontekstu u kojem su prosječne kognitivne sposobnosti niže (Marsh, 2005).