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Emotions, motivation and self-regulation in boys' and girls' learning mathematics

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Abstract: The purpose of our study was to investigate the relationship of affective and motivational processes and self-regulation in mathematics in secondary school students. We were interested in finding out if these relationships differ between boys and girls. Second, we predicted the use of cognitive and metacognitive strategies from emotional and motivational variables. A total of 397 students (145 boys and 252 girls) attending the first year of grammar schools in Slovenia participated in the study. Emotions were measured with the three scales assessing students' positive and negative emotions during math classes, during learning math at home and during math tests. Students' goal orientations were measured by Achievement Goal Questionnaire Revised (AGQ-revised; Elliot & Murayama, 2008), self-efficacy by Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000) and cognitive and metacognititve strategies by Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991). More significant correlations between emotional and motivational dimensions were found for girls than for boys. The opposite was true for the relationship between emotional dimensions and strategies. Further hierarchical regression analyses showed that emotions explained a greater amount of variance in using cognitive and metacognitive strategies in boys than in girls. In both genders, positive emotions during learning math at home and math test are the best predictors of (meta)cognitive strategy use. Among motivational variables, only performance goal orientation explained significant amount of variance in all strategies in girls over and above emotional variables. Implications of emotional and motivational dimensions for the use of cognitive and metacognitive strategies in learning math are discussed, as well as implications for further research.

Keywords: emotions, motivation, self-regulation, mathematics, academic achievement

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Čustva, motivacija in samoregulacija fantov in deklet pri učenju matematike

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Povzetek: Namen študije je bil raziskati odnos afektivnih in motivacijskih procesov s samoregulacijo pri matematiki pri srednješolcih. Zanimalo nas je ali se te povezave razlikujejo glede na spol ter koliko čustvene in motivacijske spremenljivke napovedujejo uporabo kognitivnih in metakognitivnih strategij dijakov. V raziskavi je sodelovalo 397 slovenskih dijakov prvega letnika gimnazije (145 fantov in 252 deklet). Dijaki so s pomočjo treh lestvic ocenili pozitivna in negativna čustva pri matematiki v treh kontekstih: med poukom, med učenjem doma in med preizkusom. Ciljno motivacijske orientacije dijakov smo merili z revidiranim AGQ vprašalnikom (Achievement Goal Questionnaire Revised AGO-Revised; Elliot in Murayama, 2008), lastno učinkovitost dijakov s PALS-om (Patterns of Adaptive Learning Scales PALS; Midgley et al., 2000), kognitivne in metakognitivne strategije pa z MSLQ (Motivated Strategies for Learning Questionnaire MSLQ; Pintrich et al., 1991). Pri dekletih smo med čustvenimi in motivacijskimi dimenzijami našli več pomembnih korelacij kot pri fantih, pri fantih pa več pomembnih povezanosti med čustvi in strategijami. Hierarhična regresijska analiza je pokazala, da čustva pri fantih pojasnijo več variance pri uporabi kognitivnih in metakognitivnih strategij kot pri dekletih. Pri obeh spolih pa so najbolje napovedovala uporabo (meta)kognitivnih strategij pozitivna čustva med učenjem matematike doma in pri preizkusu iz matematike. Med motivacijskimi spremenljivkami pa je pomemben del variance v uporabi vseh strategij pri dekletih pojasnila le ciljna usmerjenost v dosežek. Ob koncu izpostavljamo implikacije emocionalnih in motivacijskih spremenljivk za uporabo kognitivnih in metakognitivnih strategij pri učenju matematike in za nadaljnje raziskovanje.

Ključne besede: čustva, motivacija, samoregulacija, matematika, učni uspeh

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The purpose of the article is to show the connection between academic emotions on the one hand and motivational goals orientations and the choice of learning strategies in SRL on the other hand in the context of mathematics learning. First, self-regulation and its connection will achievement will be discussed, followed with the description of academic emotions in more detail, followed by explanation of motivational variables and the results of empirical studies of connections between academic emotions, motivational goal orientation and learning strategies.

Self-regulated learning and its elements

Self-regulated learning (SRL) is a form of learning that enables the learner to adapt to growing demand of information society and to find his way around in the multitude of new information. Student's activity in planning, monitoring and

evaluating his/hers own learning processes is the centre of SRL. Zimmerman & Schunk (2001) emphasize that SRL is about regulation of cognition (control of cognitive learning strategies), motivation and emotion (control of motivational beliefs and affects) and behaviour.

A number of models explaining the self-regulatory process and the role of different factors in the effectiveness of SRL, especially the role of cognitive and motivational factors, for example the model of Boekarts (1997), cyclical model of Zimmerman (1998) and the model of Garcia and Pintrich (1994). In all these models authors stress cognitive and motivational processes and their relation to learning achievement. The researcher in SRL usually does not include affective (emotional) processes, as they are not explicitly mentioned in any of the models presented earlier. And we can agree with the statement, posited by Pekrun, Goetz, Titz, & Perry (2002) that in the 90s of the past century research interest in emotion, rising otherwise, almost completely avoided the area of educational psychology, especially the domain of SRL. But nevertheless, the results of laboratory experiments (Bless et al., 1996; Meinhardt & Pekrun, 2003; Pekrun, 1992) revealed that emotions have an impact on the way of perception, on processing and long-term retention.

Studying academic emotions is important for many reasons: first, learners' emotional experiences are directly linked to his/hers subjective wellbeing; second, emotions have an impact on the quality of learning process and thus on learning achievement; and third, emotions have an influence on the quality of student – teacher interaction in the classroom, which consequently has an impact on teaching effectiveness (Goetz, Pekrun, Hall, & Haag, 2006).

Empirical evidence concerning the issue shows that positive emotions have positive influence on learning, especially on SRL. In SRL it is presupposed that a student plans, monitors and reflects his or her own learning process. This way of learning anticipates mental flexibility/adaptability and it is assumed that the latter is stimulated by positive emotions. Negative emotions, on the other hand, are supposed to direct the students towards learning based on external control (for example from a teacher), which results in worse self-regulation of one's learning.

Academic emotions

Reinhardt Pekrun, the leading author in the field of academic emotions research, defined academic emotions as emotions which are directly linked to learning situation in general – teaching, learning, tests and students' achievement (Pekrun et al., 2002). Pekrun et al. (2002) most often connected academic emotions with the learning process according to following dimensions: (1) task-related and self-related emotions and social related emotions, (2) according to valence as positive and negative emotions, and (3) according to their direction to process, prospective and retrospective emotions. The classification in summarized in the Table 1.

Table 1. *The domain of academic emotions*

	Positive	Negative
Task related and self-related		
Process	enjoyment	boredom
	anticipatory joy	hopelessness
	hope	anxiety
Retrospective	joy about success	sadness
	satisfaction	disappointment
	pride	shame and guilt
	relief	
Social related	gratitude	gratitude
	empathy	jealousy and envy
	admiration	contempt
	sympathy and love	antipathy and hate

Note: Adapted from "Academic emotions in students' self-regulated learning and achievement: A program of quantitative and qualitative research", Pekrun, R., Goetz, T., Titz, W., in Perry, R. P., 2002, Educational Psychologist, 37(2), str. 92. Avtorske pravice Taylor&Francis, 2002.

Task and self-related emotions are connected with an individual. This means that the feelings and thoughts, caused by an emotion, are directed backward to an individual (for example anxiety). Some emotions and associated thoughts however are directed toward other people (for example anger or jealousy). Prospective emotions are associated with an expected outcome of a learning situation (for example hope), retrospective emotions on the other hand are the emotional reactions to an actual outcome of a learning situation (for example pride in accomplished goal or shame if the goal is not accomplished).

This classification of academic emotions is important for understanding and differentiating the effects of individual types of emotions on motivational and cognitive factors in learning. In this regard Pekrun, Frenzel, Goetz, & Perry (2007) further classified emotions according to the level of activation as (i) activating or deactivating. Activating emotions are those that energize the student to action or push the student to approach or engage in a task (for example enjoyment of learning, hope for success). Deactivating emotions are those that facilitate rest, disengagement or avoidance of action (for example boredom and hopelessness).

Motivation – achievement goal orientations and self-efficacy

As already stated before, academic motivation plays an important role in students' SR behaviour, because it determines the quantity and the quality of time and

effort a student dedicates to learning, the strategies he uses in learning and therefore the learning outcome. Two motivational constructs will be used in our study to measure students' motivation, namely achievement goal orientations and self-efficacy.

Achievement goal theory proved to be a useful starting point for studying and understanding students' motivation for learning in school. Researchers (Ames, 1992; Dweck & Legget, 1988; Elliot, 1999; Harackiewicz & Sansone, 1991; Nicholls, 1984; Urdan & Maeher, 1995) generally focus on the two facets of the goal directed achievement strivings, namely mastery (that is task orientation, learning, mastery) and performance (that is ego orientation, self-enhancement, relative ability).

Mastery goals are goals directed to learning and mastery of learning content. Student who adopt this goal orientation are actively striving to develop and improve their competence, they find challenge in learning mentally demanding tasks and to gain the understanding of the subject matter. On the other hand performance goals are goals directed to present ones' own abilities. Students with this goal orientation in learning situations compare their performance with the performance of the other students, they want to show their knowledge in the best possible way, good grades are more important to them as mastery of content and the attention is directed to the self (Ames and Archer, 1998; Dweck & Legget 1988; Nicholls et al., 1990). In the mid-nineties some researcher had pointed out that performance goals can have approach or avoidance dimension. Students in achievement situations can learn to show their capabilities, to outperform other or they can learn to avoid showing their incompetence to other students or to teacher (Elliot & Harackiewicz, 1996). The subdivision of performance goals to performance approach and to performance avoidance goals was proposed. In both performance goal orientations students focus on their abilities, on the self, but in the first case the search for success prevails, while in the second, avoidance of failure prevails.

A step further in the achievement goal theory was made by Elliot and his co-workers (Elliot & McGregor, 2001; Elliot & Murayama; 2008, Elliot & Thrash, 2001) who proposed 2 x 2 achievement goal framework in which they also divided mastery goals into mastery-approach and mastery-avoidance goals. This model includes mastery-approach, mastery-avoidance, performance-approach and performance-avoidance goals. Mastery-approach goals are directed toward fulfilling once potential and to learn and understand as much as possible (Elliot & McGregor, 2001; Elliot & Murayama, 2008). Mastery-avoidance goals are directed toward trying to avoid learning and understanding less than possible in a certain situation (Elliot & Murayama, 2008). Performance-approach goals include normative component and are directed toward comparison with others. Students' goals are to be better than others in the class. Performance-avoidance goals, on the other hand, are directed toward avoiding doing worse than the others (Elliot & Murayama, 2008; Hulleman et al., 2010). Elliot & McGregor (2001) also developed the questionnaire to measure all four goal orientations, which was latter revisited (Elliot & Murayama, 2008). In our study we used the revised version of Achievement Goal Questionnaire – Revised (AGQ; Elliot & Murayama, 2008).

Another motivational dimension which can explain students' self-regulation in learning was also included in our research, namely self-efficacy. Self-efficacy belief is a judgment that an individual make about his or her ability to perform a specific task (Bandura, 1986). Self-efficacy was constantly found to be related with students' engagement in academic situations and their academic achievement is self-efficacy (Patrick, Ryan, & Kaplan, 2007; Puklek Levpušček & Zupančič, 2009; Smith, Sinclair, & Chapman, 2002).

Academic emotions, motivation and strategy use

Some authors include emotions as important factor in explaining academic motivation and achievement. Two of the most significant models on the effects of emotions are cognitive-motivational model from Pekrun (1992) and asymmetric two-dimensional model from Linnenbrink and Pintrich (2002).

The basic assumption of cognitive-motivational model (Pekrun, 1992) proposes that emotion effects achievement indirectly through different cognitive and metacognitive mediators. The most important mediators are academic motivation, learning strategies, cognitive resources and self-regulation (Pekrun et al., 2002). Single emotions have different effects on these mediators. Research reveals that positive-activating emotions are associated with increases in the efficacy of learning, negative-deactivating emotions with decreases in learning, while different studies have found different effects on learning for negative-activating emotions (c. f. Pekrun et al., 2002). Author argues that negative emotions require more cognitive resources (like attention, problem solving) than positive emotions, leaving fewer resources available for task-directed activities, and therefore leading to less efficient cognitive processing. This is proved also by empirical research of Pekrun and his colleagues (2007). The results show that positive activating emotions (enjoyment, hope and pride) significantly correlate with metacognitive, organizational and elaboration strategies, but negative activating emotions (anger, anxiety and shame) sometimes correlate with rehearsal strategies. Based on these results, authors draw a conclusion that there is a reciprocal connection between positive emotions and better learning self-regulation: positive emotions reinforce self-regulation, this leads to better achievement, which (further on) strengthens positive academic emotions.

The results of other research also confirmed connections of academic emotions with the use of specific learning strategies. For example Zeidner (2007) proved, that anxiety disrupts students' efficient processing directed at successfully completing the task. Forgas (2001) wrote that positive mood has been associated with the use of holistic and adaptive approach to learning (strategies) and negative emotions have been associated with analytical and detail-focused form (strategies) of cognitive engagement.

The other model of Linnenbrink and Pintrich (2002) explains the relationship between affective and motivational factors and presumes asymmetric and two-

dimensional relationship between affective processes (mood, emotions) and achievement goals. The influence of mood as a long lasting affective state on achievement goals is higher than the influence of short lasting emotions. Positive emotions are related with student's mastery goals, but negative mood is probably not connected with achievement goals. Goals have further effects on experiencing specific learning emotions. Orientation toward mastery goals raises positive academic emotion and lower negative academic emotions. Orientation toward performance goals is usually not connected with positive emotions, but with higher degree of negative academic emotions. Authors also presume that through academic emotions goals are indirectly also connected with achievement. The goals-emotion-achievement linkage was confirmed also by other authors (e.g., Elliot & Pekrun, 2007).

Positive relations of mastery-approach goal orientation and positive affect toward subject (Puklek & Peklaj, in print) and interest (Hulleman et al., 2010) was found. Some relations between performance-approach goals and positive emotions such as pride and enjoyment, and negative relations with boredom were also found (Daniels, Stupnisky, Pekrun, Haynes, Perry et al., 2009). The relations between performance-approach goals and anxiety are not so consistent. They range from no (Wolters et al., 1998) to relatively low (Daniels et al., 2009; Middleton & Midgley, 1997; Skaalvik, 1997). Elliot and Muruyama (2008) found positive correlation with fear of failure. Wolters (2004) and Bong (2005) also found positive correlations between performance-approach goals and self-efficacy, but Linnenbrick (2005) found no correlation with self-efficacy.

Mastery-avoidance goal orientation was found to be related to worry, anxiety, higher levels of emotionality (Elliot & McGregor, 2001), fear of failure (Elliot & Murayama, 2008). Students with performance-avoidance goal orientation show less enjoyment and more anxiety (Rowsthorne & Elliot, 1999; Skaalvik, 1997; Wolters et. al., 1996), fear of failure (Elliot & McGregor, 2001), anticipatory test anxiety and worry (Elliot & Murayama, 2008). It was also found that students with this goal orientation had lower self-efficacy (Midleton & Midgley, 1997) and academic self-concept (Murayama & Elliot, 2009).

The same pattern can be seen between achievement goals and learning strategies. A more positive pattern of relations between approach goals (mastery and performance) and learning strategies was found than between avoidance goals and learning strategies. Higher mastery-approach goals were also found to be related to deep processing in learning (Elliot & McGregor, 2001) and performance outcomes (Hulleman et al., 2010). Research of performance-approach goals and learning strategies is also inconsistent. Wolters et al. (1996) showed that performance-approach goals can be connected with task engagement, deeper cognitive strategies and regulatory use, Linnenbrink (2005) found positive connections with quality of self-regulation, Kaplan and Midgley (1997) did not find any connection with strategy use, but Elliot and McGregor (2001) found positive connections with surface processing. On the other hand results of avoidance

goals are quite clear. Mastery-avoidance goals are connected with disorganization in learning (Elliot & McGregor, 2001), and lower performance outcomes (Hulleman et al., 2010, Puklek Levpušček & Peklaj, 2011). A negative pattern can be also seen in using cognitive and metacognitive strategies. Performance-avoidance is also related to reduced use of deep learning strategies (Elliot & Murayama, 2008) and less monitoring and evaluation of learning (Wolters, 2004), less engagement in learning (Church, Elliot, & Gable; 2001), less help seeking (Bong, 2008) and more surface processing (Elliot & Murayama, 2008).

Aims of the study and hypotheses

The purpose of our study was to investigate the relationships of affective and motivational processes and self-regulation in mathematics in secondary school students. First, we were interested in establishing if these relationships differ between boys and girls. Research of gender differences in emotional, motivational processes and strategy use showed some differences between boys and girls. More positive affect toward school was found in girls (Kaplan & Maehr, 1999), but also test anxiety was one of the emotions that have been usually found to be higher in girls than in boys (Smith & Sinclair, 2005; Wolters & Pintrich, 1998). Gender differences were also fund in goal orientations and self-efficacy. Girls were found to have higher mastery-approach goal orientation (Elliot & McGregor, 2001) and higher performance-avoidance goals in math (Midgley & Urdan, 2001), but higher performance-approach goals (Wolters, 2004) and also math self-efficacy was found in boys (Fast et al., 2010; Williams and Williams, 2010; Wolters, 2004). Gender differences in the use of cognitive and metacognitive strategies in math were also found with girls showing higher levels of self-regulated strategies (Patrick, Ryan, & Kaplan, 2007).

Second, we tried to find out if the pattern of relationships between emotional, motivational variables and self-regulatory strategies was the same in boys and girls. Third, we tried to find out how emotional and motivational variables can predict the use of cognitive and metacognitive strategies in boy and girls. Research links motivation-emotion-self regulation can be particularly relevant to first-year gymnasium students who find themselves in a new achievement setting that differs considerably from elementary school. This learning environment is much more competitive, pressure for achieving is higher and at the same time, higher levels of autonomy and independence in learning are expected. Under these conditions students' strategies may be particularly susceptible to the influence of affective variables (emotional and motivational).

According to the research aims three hypotheses were developed:

Hypothesis 1: Students will differ in emotional, motivational and (meta)cognitive strategies according to their gender.

Hypothesis 2: The pattern of relationships between emotional, motivational variables and self-regulatory strategies will be different in boys and girls.

Hypothesis 3: Emotional and motivational variables will be important predictors of the use of cognitive and metacognitive strategies in boys as well as in girls.

Method

Participants

There were 397 upper-secondary students (145 boys and 252 girls) in their first grade of "*gymnasium*" program participating in the study. Students were recruited from schools in different regions in Slovenia (6 schools, 13 classrooms). The average age of students was 15.67 years.

Measures

Emotions in learning. Students' emotions were measured with Emotions in Learning Scale (ELS). The instrument developed for the purposes of the study. It consists of eight emotions, four positive (joy, hope, pride, relief) and four negative emotions (anger, anxiety, shame, hopelessness). Students answered the question of how often they felt a certain emotion during three different learning situations in math: during classes, during learning at home and during taking tests on a five-point scale (1–*never*, 2–*rarely*, 3–*sometimes*, 4–*often*, 5–*always*). Cronbach α coefficients for positive emotions in math classes were .68, for home learning were .67 and for tests taking were .67. Cronbach α coefficients for negative emotions were .69, .70 and .68, respectively.

*Motivation in learning***.** Achievement Goal Questionnaire Revised (AGQ-revised; Elliot & Murayama, 2008) was used to measure students goal orientations. Questionnaire is based on 2x2 framework of achievement goal orientations measuring four achievement goals: mastery approach goals, mastery avoidance goals, performance approach goals and performance avoidance. Questionnaire consists of four scales (each consist of 3 items) measuring students' goal orientations. Students were asked to answer how much they agreed that each item is valid for them in their math learning on a five-point scale (1–*strongly disagree* to 5–*strongly agree*). The example of item measuring students' mastery approach goal orientation is: "My aim is to completely master the material presented in math class." Cronbach α coefficients for the four scales that were obtained in the sample of North American students were .84 for mastery-approach goals, .88 for mastery-avoidance goals, .92 for performance-approach goals and .94 for performance avoidance goals. In our sample Cronbach α coefficients were .63, .70, .81 and .85, respectively.

Self-efficacy was measured with the scale from Patterns of Adaptive Learning Scales (PALS; Midgley et al., 2000). Academic Self-Efficacy Scale consists of five items measuring students' perceptions of their competence to do their math work.

The students responded to items on a five-point scale (1– *not at all true*, 2 – *usually not true*, 3 – *somewhat true*, 4 – *quite true* and 5 – *very true*). The example of item: "I can do even the hardest work in math if I try". In the research conducted by Midgley et al. (2000) Cronbach α coefficient was .78, in our study was .84.

Cognitive and metacognitive strategies. Four subscales (repetition, elaboration, organization and metacognitive strategies) of Motivated strategies for learning questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991) were used to measure cognitive and metacognitive strategies in math. Subscale repetition strategies consists of four items, subscale elaboration strategies of six items, organizational strategies of four items and metacognitive strategies of twelve items. Students answer on seven point scale (1– *not true for me at all* to 7 – *completely true for me*). An example of item from metacognitive strategies scale: "I ask myself questions to make sure I understand the material I have been studying in this class." Authors report following Cronbach α reliability coefficients: .69 for repetition strategies, .76 for elaboration strategies, .64 for organizational strategies and .79 for metacognitive strategies. In our study Cronbach α reliability coefficients were: .60, .70, .63 and .73, respectively.

Procedure

We obtained the parents' consent that their children may participate in the research. The present study uses a part of data gathered in a broader study about factors that can influence students' achievement in high school which was conducted by the authors. Testing in schools was carried out in the period from March to June 2010 during regular school hours. It took one school hour to compete the questionnaires relating to math. Scales were applied in regular school hours at the times most suitable for the school. The students first answered the questions related to the basic demographic data (gender, date of birth) followed by the scales that measured different variables related to math.

Results

First One-way ANOVA was performed to find out possible gender differences in measured variables. The results are presented in Table 1. Cohen *d* values were also calculated.

Table 2. *Results of ANOVA according to gender in affective, motivational and cognitive variables included in research*

Variables	Male			Female					
	N	*M*	*SD*	*N*	*M*	*SD*	*F*	*p*	Cohen *d*
Emotions									
Positive - class	140	12.90	3.34	249	12.51	2.83	0.99 (1,387)	.320	
Negative - class	142	7.73	2.61	245	9.00	3.13	16.68 (1,385)	.000	.42
Positive - home	140	11.36	3.08	247	12.29	3.15	7.88 (1,385)	.005	.30
Negative - home	140	7.66	2.59	244	9.11	3.30	19.92 (1, 382)	.000	.46
Positive - test	141	12.08	3.56	247	12.19	3.27	0.09 (1,386)	.770	
Negative - test	143	8.59	3.02	244	10.29	3.34	24.91 (1,385)	.000	.51
Motivation									
Mastery approach	145	11.95	2.14	249	12.48	2.06	5.83 (1,392)	.016	.25
Mastery avoidance	138	11.06	2.95	242	11.50	2.73	2.14 (1,378)	.140	
Performance approach	143	9.47	2.89	248	9.84	2.95	1.45 (1,389)	.230	
Performance avoidance	145	9.89	3.41	245	10.24	3.15	1.09 (1,388)	.300	
Self-efficacy	144	20.39	3.53	251	19.85	4.08	1.76 (1, 393)	.190	
Strategies									
Repetition	140	16.92	4.61	244	18.80	4.89	13.68 (1,382)	.000	.37
Elaboration	140	24.40	7.17	240	26.92	6.99	11.24 (1,378)	.001	.35
Organisation	142	13.89	4.81	247	16.75	5.14	29.24 (1,387)	.000	.55
Metacognitive	138	48.69	10.57	232	53.50	10.36	7.66	.000	.45

Four differences were found between boys and girls in academic emotions: in negative emotions in class, in positive and negative emotions in home learning and in negative emotions during test taking in math. Girls reported significantly higher negative academic emotions in all three learning environments and higher positive emotions during home learning. In motivational variables only one significant difference was found in mastery approach goals. Girls reported higher mastery goal orientation in math than boys. Similarly, significant differences were found in all four self-regulated strategies. Girls reported higher use of repetition, elaboration, organization and metacognitive strategies. Effect sizes of differences are small except in organizational strategies and negative emotions during test taking where they are moderate. Because of these differences all further analyses were performed separately for boys and girls.

Pearsons' correlation coefficients were calculated separately for boys and girls. They are presented in Table 3. Results showed similar patterns of significant intercorrelations among the variables measuring academic emotions, among student motivational variables and among cognitive and metacognitive strategies. Only two differences between boys and girls were found. Correlations between negative academic emotions in different settings were higher in girls than in boys. In girls, a significant positive correlation was also found between mastery-avoidance and performance-avoidance goal orientation that was not found in boys.

Positive emotions in math class, in learning at home and during math tests taking were low-positively related with all motivational variables in girls, except mastery-avoidance goal orientation. Negative emotions in class and during test taking were also low-positively related with performance-avoidance goal orientation in girls. Negative emotions in all three situations were also low and negatively related with math self-efficacy. In boys, the pattern of correlations was similar for positive emotions during math classes and home learning and all motivational variables as in girls. All correlations were low and positive. Positive emotions during math test taking were low and positively related only with math mastery goal orientation and self-efficacy. But negative emotions in all three situations were only low negatively related with self-efficacy. In sum, less significant correlations were found between academic emotions and motivational variables in boys.

Positive emotions were also low-positively related with all (meta)cognitive strategies in girls and in boys, with the exception of correlation between positive emotions during test taking and elaboration in boys. In girls, two low-positive correlations were also found between negative emotions during math classes and organizational strategies and negative emotions during test taking and metacognition. In girls, low and positive correlations were also found between all motivational variables and (meta)cognitive strategies, except between mastery avoidance goal orientation and organizational strategies. In boys, low-positive correlations were also found between all motivational variables and (meta)strategies, but between performance-avoidance goal orientation, repetition and organizational strategies and between self-efficacy and organizational strategies. In sum, comparison between boys and girls also showed less statistically significant correlations between emotional, motivational variables and strategies in boys than in girls.

A series of hierarchical regression analyses were computed to predict the use of cognitive (repetition, elaboration and organization strategies) and metacognitive strategies for boys and girls. In all analyses, academic emotions were entered as the first step in regression analysis and motivational variables were entered as the second step.

As shown in Table 4 both sets of variables predicted significant amount of variance in using repetition strategies in boys. Emotional variables were found to predict repetition better than motivational variables. Among academic emotions positive emotions were a significant predictor. Positive emotions during math class

Table 3. *Pearsons' correlation coefficients among affective, motivational and cognitive variables included in research for boys and girls*

Variab les	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	
Emotions															
1. Positive - class	-	.03	.51***	.02	.50***	.04	.34***	.13*	.30***	.27***	.29***	.27***	.20**	.18*	.21***
2. Negative - class	.16	-	.10	.75***	-.06	.70***	.07	.11	.12	.17**	-.19**	-.02	.00	.04	.07
3. Positive - home	.56***	.13	-	.02	.47***	.05	.34***	.16*	.28***	.21***	.37***	.35***	.36***	.32***	.33***
4. Negative - home	.19*	.58***	.11	-	-.06	.75***	-.01	.06	.02	.06	-.17**	-.06	-.05	.05	.06
5. Positive - test	.41***	-.04	.36***	.01	-	-.10	.18**	.09	.18**	.16*	.31***	.16*	.10	.10	.18**
6. Negative - test	.08	.61***	.16	.46***	-.02	-	.02	.08	.10	.13*	-.22***	.02	-.01	.10	.11
Motivation															
7. Mastery approach	.28***	-.11	.25**	-.08	.26**	-.13	-	.44***	.52***	.21***	.36***	.24***	.34***	.23***	.25***
8. Mastery avoidance	.17*	-.03	.27**	.02	.02	-.03	.36***	-	.34***	.33***	.23***	.18**	.14*	.10	.14*
9. Performance approach	.25**	-.10	.31***	-.02	-.02	-.09	.25**	.21*	-	.67***	.29***	.30***	.35***	.29***	.31***
10. Performance avoidance	.13	.02	.18*	.05	.04	.04	.36***	.31***	.70***		.19**	.18**	.27***	.12*	.21**
11. Self-efficacy	.33***	-.23**	.33***	-.17*	.34***	-.23**	.37***	.22**	.43***	.22**	-	.15*	.23***	.18**	.13*
Strategies															
12. Repetition	.17*	.11	.39***	.10	.31***	.10	.29***	.23**	.29***	.10	.21*	-	.66***	.66***	.64***
13. Elaboration	.19*	.09	.31***	-.02	.39***	.04	.27***	.16	.29***	.16*	.26**	.69***	-	.66***	.67
14. Organisation	.24**	.19*	.36***	.12	.24**	-14	.20*	.23**	.23**	.15	.13	.67***	.66***	-	.58***
15. Meta-cognitive	.19*	.16	.32***	.02	.37***	.18*	.21*	.25**	.17*	.18*	.66***	.18*	.66***	.69***	.59***

*Note: Above the diagonal are results for girls, below the diagonal are results for boys. N for individual correlations for girls range from 225 to 247 and N for boys range from 123 to 144. *p < .05. **p < .01. ***p < .001.*

were a negative predictor of repetition, but positive emotions during learning at home and during test taking were positive predictors of repetition in boys. Among motivational variables, performance approach was a positive predictor of repetition and performance-avoidance approach was a negative predictor. In total 32% of variance in use of repetition strategies was explained by academic emotions and motivation for boys.

In comparison with boys, only academic emotions significantly predicted their use of repetition in girls. Two positive academic emotions, namely positive emotions in class and in home learning positively predicted self-reported use of repetition in math. Although motivational variables together did not additionally predicted significant amount of variance, performance approach was the individual significant predictor in girls, too. In girls, only 17% of variance in repetition can be explained by academic emotions and motivation.

Table 4. *Results of hierarchical regression analysis for variables predicting repetition strategies for boys and girls*

	Source for use of repetition strategies							
	Repetition – boys				Repetition – girls			
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1: Emotions								
Positive - class		-.19		-.25*		.18*		.15
Negative - class	.23***	.07		.12		-.03		-.08
Positive - home		.43***		.33**	.13***	.24**		.23**
Negative - home		.01		.03		-.13		-.08
Positive - test		.24**		.15**		-.05		-.05
Negative - test		-.01		.04		.09		.05
Step 2: Motivation								
Mastery approach				.15				-.08
Mastery avoidance			.09*	.11			.04	.00
Performance approach				.32**				.20*
Performance avoidance				-.25*				-.02
Self-efficacy				.05				.15
Total R^2	.23		.32		.13		.17	
N	123				216			

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5. *Results of hierarchical regression analysis for variables predicting elaboration strategies for boys and girls*

	Source for use of elaboration strategies							
	Elaboration – boys				Elaboration – girls			
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1: Emotions								
Positive - class		-.12		-.20		.01		.02
Negative - class	.21***	.21		.26*		.04		-.05
Positive - home		.24*		.16	.12***	.31**		.24**
Negative - home		-.09		-.08		-.10		-.01
Positive - test		.36***		.29**		-.09		-.09
Negative - test		-.08		-.03		-.11		.06
Step 2: Motivation								
Mastery approach				.17				.27***
Mastery avoidance			.07	-.01			.12***	-.13
Performance approach				.19				.17**
Performance avoidance				-.09				.13
Self-efficacy				.12				-.06
Total R^2	.21		.28		.12		.24	
N	126				216			

*$p < .05$. **$p < .01$. ***$p < .001$.

Results presented in Table 5 are related to the use of elaboration strategies. In boys, only academic emotions significantly predicted the use of elaboration strategies in math. Motivational variables did not prove to be an additional significant predictor. Positive emotions during home learning and test taking, but also negative emotions during class were positive predictors of elaboration strategies use in boys. Both sets of variables explained 28% of variance. Contrary to boys, both sets of variables proved to be significant predictors of elaboration strategies in girls. Among emotional variables, positive emotions during math home learning were a positive predictor of elaboration strategies and among motivational variables girls' mastery approach and performance approach were also positive predictors of their elaboration strategies. Both sets of variables explained 24% of variance.

Table 6. *Results of hierarchical regression analysis for variables predicting organisation strategies for boys and girls*

	Source for use of organisation strategies							
	Elaboration – boys				Elaboration – girls			
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1: Emotions								
Positive - class		.01		-.03		.01		-.03
Negative - class	.17***	.15		.18		-.07		-.10
Positive - home		.30**		.23**	.10***	.27***		.23**
Negative - home		.03		.03		.01		.04
Positive - test		.13		.07		.07		.07
Negative - test		-.03		.01		.13		.10
Step 2: Motivation								
Mastery approach				.09				.11
Mastery avoidance			.04	.12			.05*	-.05
Performance approach				.15				.26**
Performance avoidance				-.08				-.09
Self-efficacy				.03				-.05
Total R^2	.17		.21		.10		.15	
N	126				216			

*$p < .05$, **$p < .01$, ***$p < .001$.

Results relating to organization strategies (Table 6) showed that in boys, only academic emotions significantly predicted their use. Positive emotions during home learning were the only significant predictor. In girls, both sets of variables were significant predictors. Positive emotions during home learning and performance-approach goal orientation were positive predictors for organization strategy use. In boys, 21% of variance in organization strategies was explained by emotional and motivational variables, in comparison with girls, where 15% of variance was explained.

Table 7. *Results of hierarchical regression analysis for variables predicting metacognitive strategies for boys and girls*

	Source for use of metacognitive strategies							
	Elaboration – boys				Elaboration – girls			
Predictors	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step 1: Emotions								
Positive - class		-.11		-.15		.11		.07
Negative - class	.15***	.19		.22*		-.03		-.10
Positive - home		.24*		.18	.11***	.26**		.22**
Negative - home		-.16		-.15		-.03		.02
Positive - test		.34***		.28**		-.03		-.03
Negative - test		.14		.18		.11		.08
Step 2: Motivation								
Mastery approach				.11				.10
Mastery avoidance			.03	.17			.05*	-.01
Performance approach				.17				.20*
Performance avoidance				-.10				-.02
Self-efficacy				.03				-.10
Total R^2	.25		.28		.11		.16	
N	120				207			

*$p < .05$. **$p < .01$. ***$p < .001$.

Finally, metacognitive strategy use was also predicted. Results (Table 7) showed differences between boys and girls again. Only academic emotions were significant predictor of metacognitive strategy use in boys. First positive emotions during home learning and test taking were positive predictors of metacognitive strategy use, but when motivational variables were entered into regression analysis, negative emotions during math class and positive emotions during test taking become positive predictors of metacognitive strategy use. For girls, both sets of variables significantly predicted metacognitive strategies. Individual significant predictors were positive emotions during home learning and performance-approach goal orientation. Greater amount of variance was explained by predictors for boys (28%) than for girls (16%).

To sum up, the results of regression analyses showed that both emotional and motivational variables proved to predict strategy use differently in boys and in girls. Emotional variables in both predicted greater amount of variance in strategy use than motivational variables. Another important finding is that among academic emotions, most important are positive academic emotions during home learning and test taking which are the most frequent positive predictors of different strategy use. Only in boys

negative emotions during math learning in class can also predict elaboration and metacognitive strategy use. Some other differences between boys and girls were also found. In girls, positive emotions during home learning are the only predictors of all strategies, but in boys, other emotions are also important, such as positive emotions during test taking (for repetition, elaboration and metacognitive strategies), positive strategies in class (for repetition) and negative strategies during class learning (for elaboration and metacognitive strategies). The difference between boys and girls is also in the importance of goal orientations in strategy use. For boys, only performance-approach and performance-avoidance goals were predictors of repetition. For girls, performance-approach goal orientation was an important predictor of all strategies and mastery-approach goal orientation was also an important predictor of elaboration strategies. Thus, for girls goal orientations are more important predictors for majority strategies than for boys, the only exception being repetition. Another important difference is in the amount of explained variance. More variance can be explained with academic emotions and motivation in boys than in girls.

Discussion

The purpose of our study was to investigate the relationships of emotional, motivational variables and use of self-regulatory strategies in secondary school students learning mathematics. The results confirmed different patterns of relationships for girls and for boys and therefore acknowledge the importance of analyzing this relationships separately according to students' gender. Results also revealed that emotions can have a different effect on (meta)cognitive strategy use in different learning environments, during classes, during home learning and during test taking.

Differences in emotional, motivational variables and (meta)cognitive strategies

The results related to gender differences in emotional, motivational and cognitive variables relating to math learning are in accordance with prior research which showed the existence of differences in all three domains of SRL (Elliot & McGregor, 2001; Fast et al., 2010; Kaplan & Maehr, 1999; Patrick et al., 2007; Smith & Sinclair, 2005; Wolters, 2004). Therefore we can accept the first hypothesis about the differences in emotional, motivational and (meta)cognitive strategies. Regardless of this fact, some inconstancies with earlier research were also found which are discussed.

More positive emotions were found in girls during math home learning, but no differences were found between boys and girls during class learning and test taking. On the other hand girls report higher levels of negative emotions in all there learning situations. Our results therefore confirmed the exiting results that showed higher levels of test anxiety in girls in comparison with boys (Smith & Sinclair, 2005;

Wolters & Pintrich, 1998) and also further extend this pattern of higher emotionality to anger, shame and hopelessness which also compose negative emotionality scale. Experiencing higher levels of negative emotions is not related only to test anxiety, but can be also seen during learning math in class and at home. We can conclude that in general, girls experience more negative emotions during learning math in different context than boys.

In motivational variables only one significant difference was found in master-approach goals orientation. The results are the same as those found by Elliot and McGregor (2001) who also found higher mastery-approach goal orientation in girls in tertiary education. In mathematics, girls are directed toward fulfilling their potential and learning as much as possible more than boys. Contrary to research that also found higher performance-avoidance goals in math in girls (Midgley & Urdan, 2001) and higher performance-approach goals in math in boys (Wolters, 2004) no difference between boys and girls was found in our research. In general, we can conclude that girls show more positive achievement motivation than boys. Contrary to expectations no differences were found in self-efficacy which is motivational variable most often found to be higher in boys than in girls even when researchers take the actual achievement (grades) into account (Williams & Williams, 2010).

Higher results for girls were also found in their reported use of (meta)cognitive strategies during math learning as it was found in prior research (Patrick et al., 2007). Girls repeat content in math more often than boys, probably they solve more math problems for homework, use more elaboration and organization strategies during learning and also more regulatory strategies as planning, monitoring, reviewing, evaluating and correcting mistakes. This higher level of strategic learning can be one of the reasons for higher math grades in Slovene girls in grammar schools in comparison with boys (Japelj Pavešić & Cankar, 2010).

These results in more adaptive motivation in girls than in boys and in absence of differences in self-efficacy, which may be explained with our school system that does not allow students to choose the amount of math in primary or secondary school. The same amount of math is required for all students. Thus, girls could not choose less math lessons than boys, as in other countries, with less strict system and more flexibility in curriculum. This fact, together with their directedness to deep understanding, more frequent use of (meta)cognitive strategies could be reflected not only in their grades, but also in their math self-efficacy which then resembles their actual achievement more closely.

Patterns of relationships between variables for boys and girls

Our second hypothesis was related to different patterns of relationships between emotional, motivational and (meta)cognitive strategy variables in boys and girls. Results contrary to expectations show only a few differences in correlational patterns

between boys and girls. Therefore, our second hypothesis can be only partially confirmed. Results relating to inter-correlations among emotional, motivational and (meta) cognitive variables showed only two differences in girls' positive correlation existed between mastery-avoidance and performance-avoidance goals which are not present in boys. Results also showed that inter-correlations between negative emotions in different settings are higher in girls than in boys, indicating that boys may differentiate these negative experiences during math learning more than girls do.

Regarding the results about correlations between emotional and motivational variables, the only difference was in number of significant correlations. Two more significant correlations were found in girls than in boys: between positive emotions in class and performance-avoidance goals and between negative emotions in class and performance-avoidance goals. Higher levels of either positive or negative emotions have higher impact on avoidant motivation for girls in math. It is more important for them not to do worse than others in class in comparison with boys.I

Comparison of results including relations between emotions and (meta)cognitive strategies shows two differences. Correlations between positive emotions during test taking and organizational strategies are higher for girls than for boys, once again indicating that positive experiences during math test are more important for girls. On the other hand, negative emotions during class in boys are connected with higher use of organizational strategies, and negative during test are connected with higher use of metacognitive strategies. In girls, more connections between self-efficacy and (meta)cognitive strategies were found than in boys.

Predictive power of emotions and motivation in strategy use for boys and girls

In the third hypothesis we predicted that emotional and motivational variables will be important predictors of cognitive and metacognitive strategy use in boys and in girls. Our results again only partially confirmed the third hypothesis. Both sets of variables proved to be significant predictors of repetition in boys and in elaboration, organization and metacognitive strategies in girls. Thus, in our research a different pattern in predicting (meta)cognitive strategy use in math learning according to gender was found.

In boys the most important predictor of repetition is negative emotions in school and positive emotions during home and during test taking. For organizational strategies only positive emotions during home learning are an important predictor, but for elaboration and metacognitive strategies in boys, positive emotions during test taking and negative emotions during class learning are also significant predictors. In girls the only significant academic emotion for strategy use is positive emotions during home learning. It seems that, contrary to girls, some amount of negative emotions during math test taking can be as sign for them that they have to exercise more and that they have to monitor and regulate their math learning more carefully. Boys can

also understand positive emotions during class a sign that everything is alright with their math knowledge and they do not need any additional repetition in subject matter. On the other hand the only significant predictor for all strategies in girls was positive emotions during math home learning. Joy, hope, pride and relief when they are learning math alone at home help them approach math learning more strategically, which can later impact their math achievement.

Another difference related to gender in predicting (meta)cognitive strategies was found. In boys, the only motivational variables that predicted their repetition over and above academic emotions were performance-approach and performance-avoidance goals. Performance-approach goals were a positive predictor, but performance-avoidance goals were a negative predictor as was already confirmed in other research. For boys, an adaptive pattern for using repetition in math would be to experience positive emotions during home learning and during math test and to learn to do better than other students in the class. For girls performance-approach goals also proved to significantly predict all (meta)cognitive strategies over and above academic emotions. In elaboration, an additional significant predictor which explained even greater amount of variance was mastery-approach goals. To use elaboration strategies (to compare, summarize, explain or apply to different situations) in learning the subject matter, more effort is needed than to use repetition or organization. In these situations motivation to master subject matter in combination with performance-approach goals proved to be the best predictor of strategy use which was already confirmed in multiple goals approach in achievement goal orientation research (Linnenbrink, 2005; Smith & Sinclair, 2005).

Another difference according to gender is the amount of variance explained with emotional and motivational variables in strategy use in boys and in girls. Emotional and motivational variables explained greater amount of variance in boys than in girls. Emotional experiences in different situations during math learning are more important for boys than for girls. They can explain up to 23% of variance of repetition, 20% of variance in elaboration, 17% of organization and 21% of metacognitive strategies in boys. On the other hand, in girls, between 10% and 13% of variance for their (meta)cognitive strategy use could be explained with their academic emotions. Other individual variables not included in our research could be more important in explaining the girls' strategy use such as volition, interest, prior achievement, personality dimensions as well as variables in learning environment such as teacher and parent expectations regarding their math achievement (Bong, 2008; Friedel, Cortina, Turner, & Midgley, 2007; Puklek Levpušek & Zupančič, 2009).

Conclusion

Some final conclusions with implications for educational practice as well as for further research can be drawn from our research. The current study once again confirmed

the existence of gender differences in students' emotional, motivational and cognitive variables of their self-regulation in mathematics and therefore the importance to take these differences into account in educational practice. Differences were found in level of experiencing and reporting academic emotions, goal orientations and (meta)cognitive strategies and in relative importance of individual academic emotions and achievement goals in predicting strategy use. Teachers should be aware of these differences in designing optimal learning environment in which positive emotions during learning either in school or learning math in school could be experienced that is even more important for girls who experience higher levels of negative emotions in math. Carefully structured feed-back during math classes about strengths and weaknesses in ones' own learning combined with the instructions about (meta)cognitive strategies that can be used to improve them can help students to see realistic level of their knowledge. This could help students understand the need for more repetition and regulatory strategies use, that will be especially beneficial for boys and at the same time, it could direct students to mastery of declarative and procedural math knowledge, which could be beneficial for girls as well as for boys. Teachers should be attentive to promote positive emotions by enabling students, especially girls, to experience positive emotions during home learning by giving them homework, math problems, in which they can be successful. They also have to be careful in constructing math tests in such a way that they will not increase students' negative emotions, that is by avoiding too demanding test. This is especially important for boys. Although the research showed different patterns of math self-regulatory processes in boys and girls in the beginning of secondary school, some improvement that can further explain the nature of these differences more thoroughly can be used in future research. In our research, academic emotions were investigated only according to their positive or negative dimension. An important step further would be to look at individual positive and negative emotions and see their relative importance for strategy use in future research. Therefore the construction of short but reliable scales for individual emotions is also advised. Future research should also include some other dimensions that could have an effect on gender differences in students' academic emotions, motivation and strategy us. Parents' and teachers' expectations and their support in math classes could be among the most important ones.

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