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Math self-regulated learning assisted by metacognitive support by reviewing sex differences in mathematics anxiety

Fenty Rahmawati Fajri; Mohammad Faizal Amir*
Universitas Muhammadiyah Sidoarjo, Indonesia
*Corresponding Author. E-mail: faizal.amir@umsida.ac.id

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ABSTRACT

The study aims to analyze the effect of mathematics self-regulated learning (MSRL) assisted by metacognitive support (MS) by reviewing sex differences (SD) in mathematics anxiety (MA). The reason is that MA causes students to have difficulty in learning, so good strategies and approaches are needed. In several studies, there is a relevant relationship between MA, SRL, and MS. This research is quantitative research using Spearman Rho analysis and ordinal regression analysis, with the research population being 3rd-grade students of primary schools in Sidoarjo, East Java. The instruments used in data collection were questionnaires and tests declared valid and reliable. The validity and reliability of the instrument were obtained through content validity assessment and item analysis testing. The results showed a relationship between SRL and MS to MA. There was a positive effect of MS-assisted MSRL in terms of SD on MA. Furthermore, the average student had a positive MS and a high MSRL. The highest MA students are at the moderate level, with a percentage of 79%, and are dominant in the affective aspect. However, when viewed from the SD, the MA showed that female students were more anxious than male students. Thus, the MS-assisted SRL has a good influence when viewed from SD to MA. The recommendation from this research is so that MS and SRL strategies can be implemented optimally. Teachers must prepare and explore the implementation of using the strategies and approach more deeply.

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INTRODUCTION

The problem of mathematics anxiety (MA) has attracted the attention of researchers and has become the main focus of research in psychology and education (Auliya, 2016). Students who experience MA are anxious, nervous, restless, and tense when faced with mathematical questions. This MA is usually seen when students are faced with problem-solving and reasoning (Kesici et al., 2011). The researchers argue that students' MA is caused by the practice of learning mathematics by teachers who emphasize rote "products" (not processes to build knowledge) (Ramirez, Hooper, et al., 2018). Further, Ramirez, Hooper, et al. (2018) reveal the rote practice of learning mathematics based on the MA experienced by the teacher. In this case, a high MA teacher causes a lack of self-confidence, fear of failure, teaching styles, ineffective learning practices, and non-engagement of students. In addition, a high MA affects the inhibition of students' working memory (Ramirez et al., 2016; Vukovic et al., 2013). This high MA of students results in low math performance and students' math behavior, especially in problem-solving (Núñez-Peña et al., 2013; Radišić et al., 2015).

Evaluation of MA in the learning and teaching process requires more attention. This is because MA can hinder student learning processes and reduce student learning outcomes. The

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higher the number of MA students, the lower the learning outcomes (Mayudana, 2020). This can be seen from the behavior of students who avoid mathematics, difficulty learning mathematics, and a lack of understanding of concepts (Hembree & College, 2015).

Learning that has the potential to reduce MA is oriented toward problem-solving, reasoning, and deep understanding (Jiang et al., 2021). Metacognitive learning encourages students to understand, reason, solve problems, and grow student awareness (Peña-ayala, 2015). Students also have high performance (Balashov et al., 2021) to support students' metacognitive awareness. This study utilized metacognitive support (MS), which consists of metacognitive strategy and metacognitive questioning.

Several studies by experts indicate the relevance of the relationship between MSRL and MS in learning mathematics. Tzohar-rozen (2014) mentioned that SRL intervention in mathematics learning (or MSRL) resulted in improvements in students' metacognitive and motivational-emotional aspects of self-regulation in arithmetic. Kaphesi (2017) found that SRL was confirmed as a predictor of MA students in secondary schools in addition to student motivation factors. Roick and Ringeisen (2018) found SRL helps students to grow students' awareness in integrating the use of metacognitive, cognitive strategies in college. In the perspective of SRL as a students' ability, Özcan (2016) find the relationship between metacognitive experience and students' mathematical problem-solving skills.

Experts have provided definitions and components of MSRL, MS, and MA. In this study, researchers used the term MSRL as an SRL strategy in learning mathematics. Thus, the underlying definition of MSRL is built on SRL. Adam et al. (2017) described SRL as a learning strategy that is oriented toward setting goals and preparing plans before students start learning. Roick and Ringeisen (2018) defined SRL as a learning strategy that emphasizes the independence of students' learning in managing, controlling, and monitoring their learning progress independently. Losenno et al. (2020) explained that SRL has four learning stages: task definition, planning, enactment of learning strategies, and evaluation.

Concerning MS, Kramarski et al. (2010) defined MS as a strategy to support students' metacognitive awareness. Specifically, metacognition is a person's knowledge about the learning process and how to learn on his own (Carruthers, 2014). The metacognitive aspects consist of planning, monitoring, and evaluation (Erdmann et al., 2019). Furthermore, Kramarski et al. (2010) said that MS consists of metacognitive strategy and metacognitive questioning. Metacognitive strategies are related to efforts to train students in planning, monitoring themselves, and evaluating their learning (Malley et al., 1985). Meanwhile, metacognitive questions are related to elaborating and assessing the depth of students' conceptual understanding in order to solve problems (Schellings et al., 2013).

Concerning MA, Gabriel and Buckley (2020) defined MA as a barrier for students in learning mathematics and as an obstacle to the development of students' metacognitive processes, while Hlalele (2012) defined MA as a feeling of tension, mental disorganization, and helplessness when someone faces mathematics. Furthermore, Baloğlu and Balgalmiş (2010) explained that MA consists of three aspects: cognitive, affective, and psychomotor. The cognitive aspect is indicated by the form of empty thoughts and negative self-talk to avoid mathematics. The affective of MA is an aspect that is characterized by distrust of abilities. This aspect is indicated by symptoms of lack of confidence, fear of looking stupid, and loss of identity. Meanwhile, psychomotor reactions are indicated by symptoms of sweating, nausea, and a fast heart rate (Whyte & Anthony, 2012).

Another study found that sex differences (SD) also have a relationship with MA experienced by students (Geary et al., 2019). Females are more anxious than males when engaging in math. This has an impact on low math performance and high math avoidance (Delage et al., 2022). In addition, the perception of mathematics makes a person have different assumptions about mathematics, so this is the reason for mathematical anxiety in terms of SD (Zirk-sadowski et al., 2014).

Previous expert studies indicated that MSRL could decrease students' MA with the support of MS. Kramarski et al. (2010) confirmed that MS-assisted MSRL resulted in the decline of MA primary students. Gabriel and Buckley (2020) showed that SRL skills in mathematics learning allow the deterioration of students' MA. Kahreh et al. (2018) practice using the SRL strategy affects the decline in MA for high school students with dependent cognitive style. Tashtoush et al. (2020) have confirmed that the SRL strategy effectively reduces the MA levels of male and female students in mathematics courses at the college level.

However, those studies have not been efforts to evaluate achievements in integrating MSRL and MS in learning by reviewing SD so that they can be optimal in reducing MA still need further evaluation for primary students. This is because SD is the main contributor in distinguishing MA experienced by students in learning mathematics (Sokolowski et al., 2019). Gender differences also affect students' psychology in learning mathematics, apart from international cognitive and non-cognitive factors affecting mathematics and science (Parker et al., 2018). In addition, the results of studies on MA by reviewing SD still show differences. The study by Wang et al. (2020) found a longitudinal negative reciprocal relationship between MA in male students but not in female students. Vukovic et al. (2013) showed that the MA level of students had no significant difference based on SD background.

Thus, this study aims to analyze the effect of MSRL supported by MS by reviewing SD in MA for primary students. This study has several benefits. First, this study is important to fill the gap left by previous researchers, namely that studies on MSRL to reduce MA has been proven, but there are no studies that focus on reviewing SD involving primary students. Second, this study can clarify the position of SD against MA students. This is because previous studies still show differences in students' MA when reviewing SD. Thirdly, it is anticipated that the results of this study will provide the first empirical evidence that SD differences among MA primary students can be reduced. Overall, MSRL's advantages are essential to the success of primary students' mathematical achievements and motivational beliefs (Mutawah et al., 2017; Yıldızlı & Saban, 2016).

METHOD

This study design used quantitative research carried out for three months from October-December 2021. Study participants were third-grade primary school students in a sub-district in Sidoarjo, East Java. The research sample comprised 92 primary students in third grade with SD, 51 male and 41 female students. The study samples were selected by purposive sampling with the criteria of third-grade primary school students experiencing high MA based on Baloğlu and Balgalmiş (2010) criteria, which determined 3.00<MA<4.00. The results of the preliminary study showed that the sample had a score of 3.4 for males and 3.6 for females.

Collecting data using questionnaires and test instruments. The questionnaire was used to measure the variables MSRL and MA, while the test was used to measure MS. The MSRL questionnaire consists of ten question items adapted from (Purdie et al.., 1996), while the MA questionnaire consists of 16 question items adapted from (Richardson & Suinn., 1972). The adaptation carried out in MSRL and MA is to change the questionnaire previously in English, into Indonesian. Meanwhile, the MS test consists of 13 questions adapted from the metacognitive instrument by Hutauruk (2016) and Kramarski et al. (2010). The adaptation carried out was using ten items of planning, monitoring, and evaluation questions on Hutauruk, then adding three items of metacognitive questions by Kramarski et al. on Hutauruk's evaluation items. Kramarski et al. (2010) mention that metacognitive questions are needed in MS-oriented learning to reduce MA and stimulate students' learning enthusiasm. Explanation of indicators, aspects, and items used in MSRL, MA, and MS instruments in Table 1.

Before using the three instruments, the validity and reliability were checked for 30 third-grade primary school students in one of the sub-districts in Sidoarjo who had the same characteristics as the sample. Checking the validity of MSRL, MA, and MS using content validity through

expert judgment conducted by two primary school teacher education lecturers. The content validity value is calculated using the Aiken's V Index formula and criteria (Aiken, 1985). Then the validity test is continued with item analysis using the product moment correlation formula with valid criteria by Rovinelli and Hambleton (1977). At the same time, checking the reliability of MSRL, MA, and MS using internal consistency using Cronbach's Alpha coefficient formula with criteria by Junior (1979). The results of testing the validity and reliability, along with the criteria, are in Table 2.

Table 1. Instruments and Indicators of MSRL, MS, and MA Variables

Variables	Aspects	Indicators	Items
MSRL	Metacognition	Recognizing own thoughts	1, 2
		Identifying and using information sources	6, 7, 8
		Planning effectively	3, 4
		Responding sensitively to feedback	9
	Motivation	Evaluating actions	10
	Behavior	Feeling unable to concentrate	5
MS	Planning	Understanding the problem	1, 2, 3, 5
		Connecting the two problems	6
	Monitoring	Developing strategies	7, 8
	Evaluating	Reflecting	4, 9, 10
		Metacognitive questions	11, 12, 13
MA	Cognitive	Having confusion in finding strategies	13
		Being tense, anxious, worried, and restless	1, 7, 8, 10, 14, 16
	Affective	Showing a lack of confidence and fear	2, 3, 6
		Feeling unhappy and uncomfortable	4, 9, 5
		Feeling unable to answer the question	10, 15
	Psychomotor	Avoiding and not wanting to take lessons	11, 12

Table 2. Validity and Reliability Test Results on Instruments

Instruments	Validity Interval	Criteria	Reliability Interval	Criteria
MSRL	0.73 > MSRL > 1.00 0.662 > MSRL > 0.863	V > 0.73 rxy > 0.361	0.921 > MSRL > 0.934	α > 0.6
MS	0.73 > MSRL > 1.00 0.395 > MS > 0.887	V > 0.73 rxy > 0.361	0.534 > MS > 0.667	α > 0.6
MA	0.73 > MSRL > 1.00 0.422 > MA > 0.846	V > 0.73 rxy > 0.361	0.915 > MA > 0.927	α > 0.6

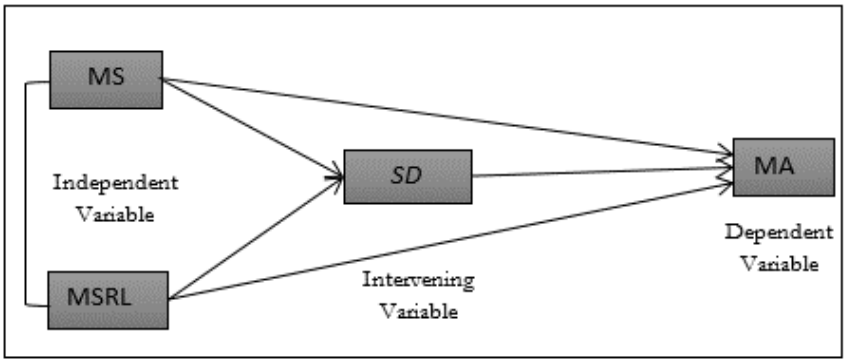

Figure 1. Relationship between variables

The MSRL and MA variables use an ordinal measurement scale with a semantic differential scale type in the form of a 1-4 Likert scale with 1 = never, 2 = sometimes, 3 = often, 4 = always.

The MSRL Likert scale 1-4 has 1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree. Using a 0-100 scale to measure MS gives respondents freedom to answer questions.

The statistical analysis used is the Spearman analysis technique and ordinal regression. This research is an experimental study where students are subjected to a treatment to determine the effect of treatment on research subjects. The relationship between variables in this study is shown in Figure 1. The relationship between the implementation of MS and MSRL by reviewing SD to reduce MA in Figure 1 is the basic idea and mapping of research variables to determine the effect of MSRL and MS on students' MA when viewed from SD.

FINDINGS AND DISCUSSION

This study used Spearman Rho analysis and ordinal regression analysis. Spearman Rho analysis was used because it was used to analyze the non-parametric relationship regarding the closeness and direction of the relationship between the variables MSRL, MS, and MA. Another reason for using Spearman Rho analysis is that the test data involved more than 30 participants with abnormal test data on the variables MSRL=0.000, MS=0.000, and MA=0.024. Meanwhile, ordinal regression analysis was used because it is used to analyze the non-parametric effect between the variables MSRL and MS towards MA when viewed from SD.

SPSS version 24 for a window performs Spearman Rho and ordinal regression. Spearman Rho uses a 0-1 correlation category. Closer to 1 means a stronger correlation. A negative correlation means that if one variable increases, the others decrease. A positive correlation indicates a unidirectional relationship; if one variable increases, so do the others. If the significance value is 0.05, the relationship is significant, and vice versa. Ordinal regression analysis uses independent variables with multicollinearity. If the data is not multicollinear, the model fit test can determine if it is good. At this stage, the researchers used Pearson deviance chi-square to determine if the model was appropriate for calculating ordinal regression coefficients.

Table 3. Correlations Spearman

		MSRL	MS	MA
MSRL	Correlation Coefficient	1.000	.091*	-.513**
	Sig. (2-tailed)	.	.390	.000
	N	92	92	92
MS	Correlation Coefficient	.091*	1.000	.273
	Sig. (2-tailed)	.390	.	.009
	N	92	92	92
MA	Correlation Coefficient	-.513**	.273	1.000
	Sig. (2-tailed)	.000	.009	.
	N	92	92	92

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

From Table 3, it can be seen that the MSRL variable has a correlation coefficient of -0.513 to MA. This indicates that there is a relationship between MSRL and MA. A negative value in the correlation indicates an opposite relationship between the two. If MSRL has a high value, then MA has a low value and vice versa. Furthermore, the value of sig is known between these two variables is 0.000. As the basis for decision-making on the Spearman rank correlation, which is sig < 0.05, it can be concluded that there is a significant relationship between MSRL and MA (Gabriel & Buckley, 2020). MS and MA have a correlation coefficient of 0.273 and a sig. of 0.009. This indicates that MS and MA have a correlation coefficient relationship between variables. In addition, there is a significant relationship between the two. On the other hand, the relationship between MSRL and MS has a low correlation coefficient of 0.091 with a positive value. It indicates that the two variables have a unidirectional relationship. If MSRL has a high value, MS also

has a high value. However, both have a sig value of 0.390, which indicates that the variable is less significant.

Based on the champion criteria in the Spearman correlation analysis, the number -0.513 in the correlation coefficient of MSRL and MA indicates that the two variables have a significant relationship. In this case, the higher the MSRL means the lower MA. This significant relationship between MSRL and MA supports research by Kesici et al. (2011) that students with high MSRL showed low anxiety.

The finding of a significant association between MS and MA in this study is in line with research by Hoorfar and Taleb (2015), who suggested a correlation between MA and metacognitive. If the MA of students is reduced, they can use their metacognitive abilities even better. The findings of another study explain that a decrease in MS causes the emergence of MA during online learning during a pandemic (Oktawirawan, 2020). As a result, they feel anxious and afraid if they cannot answer the question correctly (Suryaman et al., 2022, p.2).

Regarding the findings of this study regarding the insignificant relationship between MSRL and MS has a positive relationship. Raković et al. (2022, p.3) found that SRL correlates with students' metacognitive and positively impacts students' learning processes. Besides, MSRL, which focuses on the use of cognitive and metacognitive strategies, is proven to be able to prevent low achievement and improve the performance of all students (Stoeger et al., 2015). In addition, the results of the ordinal regression analysis with the model fit test are presented in Table 4 to determine whether MSRL and MS correlate directly with MA.

Table 4. Model Fitting Information & Goodness-of-Fit

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log-Likelihood	Chi-Square	df	Sig.
Intercept Only	528.022			
Final	491.251	36.771	2	.000
Pearson	-	1696.973	1823	.983
Deviance	-	468.024	1823	1.000

The regression model with MSRL and MA variables performs better than the regression model without these two variables, as shown in Table 4 by the value of sig 5%. It is known that the value of -2 Log-Likelihood decreases from the intercept value of 528.022 to the final value of 491.251, with a Chi-Square value of 36.771 and a significance level of 0.000. It means that the regression model with the presence of the independent variable can provide better accuracy results so that a model with independent variables is better than a model without independent variables. It has a Pearson value of 1696.973 with a significance of 0.983 (> 0.05) and a Deviance of 468.024 with a significance of 1.000 (> 0.05). This means that the model is based on empirical data or is feasible to use. Calculating the estimated parameters of the ordinal regression model reveals that the negative MSRL variable has a sig of 5%, indicating that this variable is appropriate for use with the ordinal regression model.

Thus, the likelihood that a student with a positive MSRL will have a high score and an MA is lower than that of a student with a negative MSRL. In addition, a statistical analysis of the coefficient of determination is provided in Table 5 for the purpose of determining the MSRL and MS variables' contribution to MA.

Table 5. Pseudo R-Square

Cox and Snell	.329
Nagelkerke	.330
McFadden	.066

Table 5 shows that the MSRL and MS variables can have a 33.0% effect on students' MA. Consequently, the remaining 67.0% is explained by factors not discussed in this study. Other fac-

tors that can improve students' MSRL include the role of parents, either through giving examples, encouragement, rewarding, facilitating, implementing effective strategies for reprimanding students, and other processes so as to improve their academic performance (Martinez-pons et al., 1988). Therefore, it is plausible that factors not observed in this study influenced the 67% change in MSRL variables among students. Then, to determine the level of MSRL, MA, and MS students, the scores for each questionnaire and test were categorized according to the collected data.

Table 6. Distribution of MS, MSRL, and MA Student Levels

Variables	Intervals	Level	Percentage (%)
MS	1.00 < MS < 5.00	Negative	21%
	5.00 < MS < 10.00	Positive	79%
MSRL	3.00 < MSRL < 4.00	High	88%
	2.00 < MSRL < 3.00	Moderate	12%
	1.00 < MSRL < 2.00	Low	0%
MA	1.00 < MA < 2.00	Low	20%
	2.00 < MA < 3.00	Moderate	71%
	3.00 < MA < 4.00	High	19%

The analysis results from Table 6 found that most respondents had positive MS, 79% with an interval of 5.00-10.00, where students showed positive metacognitive awareness. Besides, this study on the interval 1.00-5.00 showed that 21% of students had negative MS. This is also in line with the results of the MSRL variable analysis, which is 88% with intervals 3.00-4.00 of students in the high category. Respondents with moderate MSRL were only 12% on the interval 2.00-3.00, and there were no students with a low MSRL in this study. On the other hand, this study found that 20% on the interval 1.00-2.00 of students had a low MA level, whereas, 71% were in the moderate category at intervals of 2.00-3.00 with a moderate MA level which is the highest percentage. The MA with the high category is on the 3.00-4.00 interval, there are 19% of students.

A positive MS indicates a controlled student belief. In this case, students can positively manage their concerns about mathematics and are encouraged to solve math problems. On the other hand, negative MS indicates uncontrollable beliefs. Students experience excessive anxiety about mathematics, so students experience failure in solving mathematical problems (Spada et al., 2008). In this study, MS showed positive metacognitive awareness of students who were good at understanding problems, building connections of new knowledge with previous knowledge, developing problem-solving strategies, and reflecting on the whole problem-solving process. In addition, students also have high learning motivation due to their concern if they get bad grades. Meanwhile, negative MS shows the ability of students to understand the problem. However, students cannot develop problem-solving strategies, reflect on problem-solving, and connect new knowledge with previous knowledge.

The study findings that resulted in MSRL were generally in the high category, slightly moderate, and no students with a low MSRL. It shows a good influence of the MSRL strategy applied to students, in line with Peña-ayala (2015) who found that the students' MSRL was adequate. This study also revealed that MA students are generally in the moderate category, meaning that the presence of MS and MSRL is very influential on student anxiety. It is in line with Kramarski et al. (2010) who state that using MS more often during learning will reduce anxiety, regardless of high and low-achieving students. Thus, the use of MS indirectly affects the MSRL and MS experienced by students. Furthermore, to determine the level of student anxiety when viewed from SD, it is necessary to calculate each students' average score, especially male and female.

Table 7 presents the results of linear regression and ANOVA analysis of MA for men and women. The significance value of the female MA is 0.848 (>0.05) with an R Square of 0.007, while the significance of the male MA is 0.006 (<0.05) with an R square of 0.233. This showed that MS and MSRL were not significant for female MA with an effect of 7%, but significant for male MA with an effect of 23%. This finding was similar to Núñez-Peña et al. (2016), who found

a significant relationship on male anxiety but no significant relationship on female anxiety. Taylor and Fraser (2013) explained that male MA was higher than female MA because men were more anxious about the mathematics learning process than the mathematical evaluation product. In contrast to the findings by Keshavarzi and Ahmadi (2013), the study found a score of 0.90, and there was no significant relationship between male and female anxiety. The female MA was not significant, and the MA was male-female. However, the descriptive statistics of this study showed that the MA for women is 34.46 higher than the MA for men, which is 33.84. The difference between the inferential and descriptive statistical results may be due to the unequal proportion of the number of participants. This finding is supported by Devine et al. (2012) MA level of female students is higher than that of male students. Research conducted by Indiyani also supports this statement that the anxiety of female students is higher, with an average of 70.1 compared to the average of male students of 67.9 (Sembiring & Wardani, 2021).

Table 7. MA term of SD

	MA-Female	MA-Male
N (Valid)	41	51
Mean	34.46	33.84
Std. Error of Mean	1.036	1.089
Median	34.00	34.00
Std. Deviation	6.634	7.775
Sig.	0.848	0.006
R Squrae	0.007	0.233

Table 8. Aspects of MA in Terms of SD

	MA Female			MA Male		
	Cognitive	**Affective**	**Psychomotor**	**Cognitive**	**Affective**	**Psychomotor**
Mean	11.10	14.85	8.54	11.67	14.22	7.57
Std. Deviation	3.955	4.624	2.925	3.958	5.170	3.354
Sig.	0.133	0.002	0.568	0.948	0.124	0.767
R Square	0.101	0.278	0.029	0.002	0.083	0.011

Table 8 shows the results of the analysis of three aspects of MA (cognitive, affective, and psychomotor) in terms of SD. The highest average of the MA female and MA male aspects was the affective aspect with values of 14.85 and 14.22. These results are similar to those of Jamieson et al. (2021), who found the highest MA level of students predicted the affective aspect, namely in the form of stress, which caused low test scores. Slightly different from the study by Ramirez, Shaw, et al. (2018), students' MA is caused by the disruption of students' cognitive processes.

MA female in cognitive (sig.=0.133) and psychomotor (sig.=0.568) inferentially showed no significant relationship. It was because of the sig value. >0.05. Meanwhile, the MA female on the affective aspect had a significant relationship with the sig value. 0.002. Meanwhile, in MA male, no significant relationship was found in the three aspects of MA. This is in line with the findings of Nofrialdi et al. (2018) that there is no significant difference between MA Male in all cognitive, affective, and psychomotor aspects. Meanwhile, the cognitive and psychomotor aspects of MA females are also insignificant. Grothérus et al. (2019) describe the affective aspect related to the mathematics learning performance of female students. This was indicated by the more controlled female affective, even though the MA female increases. These findings differed from Utami and Fuadiah (2018), who found that MA females and MA males had a significant relationship in all cognitive, affective, and psychomotor aspects.

It was also found that MS and MSRL affected MA females and MA males. MS and MSRL strongly influence the affective aspects of MA females and males, 27% and 8.3%, respectively. Similar to these findings, Grothérus et al. (2019) SRL in mathematics encourages the positive affective achievement of students (male and female) to learn mathematics. However, Festus et al. (2018) found that MA factors in cognitive, affective, and psychomotor did not affect male and fe-

male students' academic achievement but had a significant relationship with students' academic achievement.

The previous analysis's basis for decision-making states that MSRL and MS have a unidirectional relationship. This shows that the MSRL and MS are in the same direction, or if the student's MS is high, then the student's MSRL is also high and vice versa. One of Tian et al. (2018) findings shows a positive relationship between metacognition in mathematics learning within the SRL (MSRL) framework and student learning outcomes. A similar study by Raković et al. (2022, p.3) also found a positive correlation between SRL and metacognition. In contrast to the study's results, Delima and Cahyawati (2021) found a negative correlation between MSRL and students' learning awareness (as part of MS). This is caused by the reduced intensity of meetings between teachers and students.

Regarding the involvement of MA in learning, several related studies confirm that MS can reduce MA. Ariapooran and Mansour (2021) found that mathematics learning strategies involving metacognition affect the decline in MA. Similar findings by Özcan and Gümüş (2019) found that metacognitive experiences during learning had a direct effect on students' problem-solving performance. In this case, the success of students' problem-solving performance is influenced by the low MA. Morsanyi et al. (2019) stated that monitoring students' metacognition during problem-solving also affected decreasing MA.

CONCLUSION

The results of this study can be concluded that MSRL and MS positively affect MA. The variable MSRL with MA has a significant relationship and strongly correlates with a negative value. The MS variable with MA has a significant relationship and there is a low correlation with a positive value. The MSRL and MS have a strong and positive relationship, but these two variables do not have a significant relationship. Based on correlation coefficients between variables, it can be seen that all variables have a strong correlation coefficient except MS and MA. In addition, the significance value between variables was also considered significant except for the MSRL and MS variables.

If the MS and MSRL variables are viewed from SD to MA, it can be seen that SD has a significant relationship. In addition, there is also an average difference where the average anxiety of female students is higher than male students. This research has answered the gap left by previous researchers, namely MS and MSRL proven to be able to help reduce MA. It is proven that the variables MSRL and MS positively influence MA and its aspects, especially on the affective aspect. Hence, it can be concluded that there is a positive effect of MSRL and MS when viewed from SD to MA.

REFERENCES

Adam, N. L., Alzahri, F. B., Soh, S. C., Bakar, N. A., & Kamal, N. A. M. (2017). Self-regulated learning and online learning: A systematic review. *In International Visual Informatics Conference*, *10645*, 143–154. https://doi.org/10.1007/978-3-319-70010-6_14

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/10.1177%2F0013164485451012

Ariapooran, S., & Mansour, K. (2021). *Mathematics anxiety in male high school students in the outbreak of covid19: The role of mathematics motivated strategies and mathematical resilience*. *8*(42), 115–140. http://erj.khu.ac.ir/article-1-881-en.html

Auliya, R. N. (2016). Kecemasan matematika dan pemahaman matematis. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *6*(1), 12–22. https://doi.org/10.30998/formatif.v6i1.748

Balashov, E., Pasicichnyk, I., & Kalamazh, R. (2021). Metacognitive awareness and academic self-regulation of HEI students. *International Journal of Cognitive Research in Science, Engineering and Education*, *9*(2), 161–172. https://doi.org/10.23947/2334-8496-2021-9-2-161-172

Baloğlu, M., & Balgalmiş, E. (2010). The adaptation of the mathematics anxiety rating scale-Elementary form into turkish, language validity, and preliminary psychometric investigation. *Educational Sciences: Theory & Practice*, *10*(1), 101–110. https://files.eric.ed.gov/fulltext/EJ882725.pdf

Carruthers, P. (2014). Two concepts of metacognition. *Comparative Psychology*, *128*(2), 138–139. https://doi.org/10.1093/acprof

Delage, V., Trudel, G., Retanal, F., & Maloney, E. A. (2022). Spatial anxiety and spatial ability: Mediators of gender differences in math anxiety. *Experimental Psychology: General*, *151*(4), 921–933. https://doi.org/10.1037/xge0000884

Delima, N., & Cahyawati, D. (2021). Students' mathematics self-concept, mathematics anxiety and mathematics self-regulated learning during the covid-19 pandemic. *Jurnal Pendidikan Matematika*, *15*(2), 103–114. https://doi.org/10.22342/jpm.15.2.13200.103-114

Devine, A., Fawcett, K., Szűcs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. *Behavioral and Braind Function*, *8*(33), 1–9. https://doi.org/10.1186/1744-9081-8-33

Erdmann, K. A., Vetter, V. C., Schäferling, M., Reuner, G., & Hertel, S. (2019). How do we solve this task? *Zeitschrift Für Entwicklungspsychologie Und Pädagogische Psychologie*, *51*(3), 135–149. https://doi.org/10.1026/0049-8637/a000215

Festus, O. D., Famuyiwa, O., O Mutiu, S., & Aikabeli, L. (2018). The effects of mathematics anxiety on academic performance of moshood abiola polytechnic students. *International Journal Peer Reviewed Journal Refereed Journal Indexed Journal Impact Factor*, *4*(11), 28–38. https://wwjmrd.com/archive/2018/11/1084/the-effects-of-mathematics-anxiety-on-academic-performance-of-moshood-abiola-polytechnic-students

Finlayson, M. (2014). Improving schools addressing math anxiety in the classroom in the classroom. *Improving Schools*, *17*(1), 99–115. https://doi.org/10.1177/1365480214521457

Gabriel, F., & Buckley, S. (2020). The impact of mathematics anxiety on self-regulated learning and mathematical literacy. *ACER Australian Council for Education Research*, *64*(3), 227–242. https://doi.org/10.1177/0004944120947881

Geary, D. C., Hoard, M. K., Nugent, L., Chu, F., Scofield, J. E., & Hibbard, D. F. (2019). Sex differences in mathematics anxiety and attitudes: Concurrent and longitudinal relations to mathematical competence. *Journal of Educational Psychology*, *111*(8), 1447. https://doi.org/10.1037/edu0000355

Grothérus, A., Jeppsson, F., & Samuelsson, J. (2019). Formative scaffolding: How to alter the level and strength of self-efficacy and foster self-regulation in a mathematics test situation. *Educational Action Research*, *27*(5), 667–690. https://doi.org/10.1080/09650792.2018.1538893

Hembree, R., & College, A. (2015). The nature, effects, and relief of anxiety mathematics. *Journal for Research in Mathematics Education*, *21*(1), 33–46. https://doi.org/10.2307/749455

Hlalele, D. (2012). Exploring rural high school learners' experience of mathematics anxiety in academic settings. *South African Journal of Education*, *32*(3), 267–278. https://doi.org/10.15700/saje.v32n3a623

Hoorfar, H., & Taleb, Z. (2015). Correlation between mathematics anxiety with metacognitive knowledge. *Procedia-Social and Behavioral Sciences*, *182*, 737–741. https://doi.org/10.1016/j.sbspro.2015.04.822

Hutauruk, A. J. B. (2016). *Pendekatan metakognitif dalam pembelajaran matematika*. FKIP Unswagati Press. http://fkip-unswagati.ac.id/ejournal/index.php/repository/article/view/302

Jamieson, J. P., Black, A. E., Pelaia, L. E., & Reis, H. T. (2021). The impact of mathematics anxiety on stress appraisals, neuroendocrine responses, and academic performance in a community college sample. *Journal of Educational Psychology*, *113*(6), 1164-1176. https://doi.org/10.1037/edu0000636

Jiang, R., Liu, R. de, Star, J., Zhen, R., Wang, J., Hong, W., Jiang, S., Sun, Y., & Fu, X. (2021). How mathematics anxiety affects students' inflexible perseverance in mathematics problem-solving: Examining the mediating role of cognitive reflection. *British Journal of Educational Psychology*, *91*(1), 237–260. https://doi.org/10.1111/bjep.12364

Junior, G. A. C. (1979). A paradigm for developing better measure of marketing construct. *Journal of Marketing Research*, *16*(1), 64–73. https://doi.org/10.1177/002224377901600110

Kahreh, S. V., Imani, S., Haseli, Y. M., & Mansour, F. K. (2018). Study of effectiveness of self - Regulated of dependent cognitive style of school. *International Journal of Educational and Psychological*, *4*(2), 89–92. https://doi.org/10.4103/2395-2296.237296

Kaphesi, E. (2017). Exploring motivational factors and self-regulated learning strategies as predictors of students' anxiety in mathematics learning. *US-China Education Review*, *7*(1), 27–38. https://doi.org/10.17265/2161-623X/2017.01.002

Keshavarzi, A., & Ahmadi, S. (2013). A comparison of mathematics anxiety among students by gender. *Procedia - Social and Behavioral Sciences*, *83*, 542–546. https://doi.org/10.1016/j.sbspro.2013.06.103

Kesici, S., Baloglu, M., & Deniz, M. E. (2011). Self-regulated learning strategies in relation with statistics anxiety. *Learning and Individual Differences*, *21*(4), 472–477. https://doi.org/10.1016/j.lindif.2011.02.006

Kramarski, B., Weisse, I., & Kololshi, I. (2010). How can self-regulated learning support the problem solving of third-grade students with mathematics anxiety? *ZDM Mathematics Education*, *42*, 179–193. https://doi.org/10.1007/s11858-009-0202-8

Losenno, K. M., Muis, K. R., Munzar, B., Denton, C. A., & Perry, N. E. (2020). The dynamic roles of cognitive reappraisal and self-regulated learning during mathematics problem solving: A mixed methods investigation. *Contemporary Educational Psychology*, *61*, 101869. https://doi.org/10.1016/j.cedpsych.2020.101869

Malley, J. M. O., Chamot, A. U., Stewner-Manzanares, G., Kupper, L., & Russo, R. P. (1985). Learning strategies used by beginning and intermediate ESL students. *Language Learning*, *35*(1), 21–46. https://doi.org/10.1111/j.1467-1770.1985.tb01013.x

Martinez-pons, M., Magno, C., Mart, M., & Zimmerman, B. J. (1988). Construct validation of a strategy model of student self-regulated learning related papers construct validation of a strategy model. *Journal of Educational Psychology*, *80*(3), 284–290. https://doi.org/10.1037/0022-0663.80.3.284

Mayudana, I. K. Y. (2020). Hubungan kecemasan matematis dan adversity quotient terhadap hasil belajar matematika siswa kelas X SMK TI Bali Global Denpasar tahun pelajaran 2019/2020. *Widyadari : Jurnal Pendidikan*, *21*(2), 544–555. https://doi.org/10.5281/zenodo.4048974

Morsanyi, K., Cheallaigh, N. N., & Ackerman, R. (2019). Mathematics anxiety and metacognitive processes: Proposal for a new line of inquiry. *Psihologijske Teme*, *28*(1), 147–169. https://doi.org/10.31820/pt.28.1.8

Mutawah, M. A. Al, Thomas, R., & Khine, M. S. (2017). Investigation into self-regulation, engagement in learning mathematics and science and achievement among bahrain secondary school students. *IEJME*, *12*(3), 633–653. https://doi.org/10.29333/iejme/639

Nofrialdi, I., Maison, & Muslim. (2018). Tingkat kecemasan matematika siswa SMA Negeri 2 Kerinci kelas X MIA sebelum menghadapi tes matematika berdasarkan gender dan hubungannya dengan hasil belajar. *Edumatika Jurnal Riset Pendidikan Matematika*, *1*(2), 11–20. https://doi.org/10.32939/ejrpm.v1i2.248

Núñez-Peña, M. I., Suárez-Pellicioni, M., & Bono, R. (2013). Effects of math anxiety on student success in higher education. *International Journal of Educational Research*, *58*, 36–43. https://doi.org/10.1016/j.ijer.2012.12.004

Núñez-Peña, M. l., Suárez-Pellicioni, M., & Bono, R. (2016). Gender differences in test anxiety and their impact on higher education students' academic achievement. *Procedia - Social and Behavioral Sciences*, *228*, 154–160. https://doi.org/10.1016/j.sbspro.2016.07.023

Oktawirawan, D. H. (2020). Faktor pemicu kecemasan siswa dalam melakukan pembelajaran daring di masa pandemi covid-19. *Jurnal Ilmiah Universitas Batanghari Jambi*, *20*(2), 541. https://doi.org/10.33087/jiubj.v20i2.932

Özcan, Z. Ç. (2016). The relationship between mathematical problem-solving skills and self-regulated learning through homework behaviours, motivation, and metacognition. *International Journal of Mathematical Education*, *47*(3), 408–420. https://doi.org/10.1080/0020739X.2015.1080313

Özcan, Z. Ç., & Gümüş, A. E. (2019). A modeling study to explain mathematical problem-solving performance through metacognition, self-efficacy, motivation, and anxiety. *Australian Journal of Education*, *63*(1), 116–134. https://doi.org/10.1177/0004944119840073

Parker, P. D., Zanden, B. Van, & Parker, R. B. (2018). Girls get smart, boys get smug: Historical changes in gender differences in math, literacy, and academic social comparison and achievement. *Learning and Instruction*, *54*, 125–137. https://doi.org/10.1016/j.learninstruc.2017.09.002

Peña-ayala, A. (2015). *Metacognition: Fundaments, applications, and trends* (P. Janusz Kacprzyk, Polish Academy of Sciences, Warsaw (Ed.); 76th ed.). Springer. https://doi.org/10.1007/978-3-319-11062-2

Purdie, N., Hattie, J., & Douglas, G. (1996). Student conceptions of learning and their use of self-regulated learning strategies: A cross-cultural comparison. *Journal of Educational Psychology*, *88*(1), 87–100. https://doi.org/10.1037/0022-0663.88.1.87

Radišić, J., Videnović, M., & Baucal, A. (2015). Math anxiety—contributing school and individual level factors. *European Journal of Psychology of Education*, *30*(1), 1–20. https://doi.org/10.1007/s10212-014-0224-7

Raković, M., Bernacki, M. L., Greene, J. A., Plumley, R. D., Hogan, K. A., Gates, K. M., & Panter, A. T. (2022). Examining the critical role of evaluation and adaptation in self-regulated learning. *Contemporary Educational Psychology*, *68*. https://doi.org/10.1016/j.cedpsych.2021.102027

Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., & Beilock, S. L. (2016). On the relationship between math anxiety and math achievement in early elementary school: The

role of problem solving strategies. *Journal of Experimental Child Psychology*, *141*, 83–100. https://doi.org/10.1016/j.jecp.2015.07.014

Ramirez, G., Hooper, S. Y., Kersting, N. B., Ferguson, R., & Yeager, D. (2018). Teacher math anxiety relates to adolescent students' math achievement. *AERA Open*, *4*(1), 233285841875605. https://doi.org/10.1177/2332858418756052

Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educational Psychologist*, *53*(3), 145–164. https://doi.org/10.1080/00461520.2018.1447384

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology*, *19*(6), 551–554. https://doi.org/10.1037/h0033456

Roick, J., & Ringeisen, T. (2018). Learning and individual differences students' math performance in higher education: Examining the role of self-regulated learning and self-efficacy. *Learning and Individual Differences*, *65*, 148–158. https://doi.org/10.1016/j.lindif.2018.05.018

Rovinelli, R. J., & Hambleton, R. K. (1977). On the use of content specialists in the assessment of criterion-referenced test item validity. *Dutch Journal of Educational Research*, *2*(49–60), 49–60. https://eric.ed.gov/?id=ED121845

Schellings, G. L. M., van Hout-Wolters, B. H. A. M., Veenman, M. V. J., & Meijer, J. (2013). Assessing metacognitive activities: The in-depth comparison of a task-specific questionnaire with think-aloud protocols. *European Journal of Psychology of Education*, *28*(3), 963–990. https://doi.org/10.1007/s10212-012-0149-y

Sembiring, I., & Wardani, H. (2021). Analisis kemandirian belajar dan kecemasan belajar matematika ditinjau dari gender siswa. *Urnal Jurnal MathEducation Nusantara*, *4*(2), 13–23. https://doi.org/10.32696/jmn.v4i2.151

Sokolowski, H. M., Hawes, Z., & Lyons, I. M. (2019). What explains sex differences in math anxiety? A closer look at the role of spatial processing. *Cognition*, *182*, 193–212. https://doi.org/10.1016/j.cognition.2018.10.005

Spada, M. M., Nikčević, A. V., Moneta, G. B., & Wells, A. (2008). Metacognition, perceived stress, and negative emotion. *Personality and Individual Differences*, *44*(5), 1172–1181. https://doi.org/10.1016/j.paid.2007.11.010

Stoeger, H., Fleischmann, S., & Obergriesser, S. (2015). Self-regulated learning (SRL) and the gifted learner in primary school: The theoretical basis and empirical findings on a research program dedicated to ensuring that all students learn to regulate their own learning. *Asia Pacific Education Review*, *16*(2), 257–267. https://doi.org/10.1007/s12564-015-9376-7

Suryaman, O., Anwar, A. S., Hadiana, O., & Sutarna, N. (2022). Penerapan hipnoterapi terhadap kecemasan belajar matematika dengan pembelajaran jarak jauh pada siswa sekolah dasar. *Jurnal Cakrawala Pendas*, *8*(1), 308–315. https://doi.org/10.31949/jcp.v8i1.1949

Tashtoush, M. A., Alshunaq, M. M., & Albarakat, A. A. (2020). The effect of using self-regulated learning learning strategy to reduce the level of mathematics anxiety among students of Al-huson university college. *Jordanian Educational Journal*, *5*(3), 306–329. https://digitalcommons.aaru.edu.jo/jaes/vol5/iss3/5/

Taylor, B. A., & Fraser, B. J. (2013). Relationships between learning environment and mathematics anxiety. *Learning Environments Research*, *16*(2), 297–313. https://doi.org/10.1007/s10984-013-9134-x

Tian, Y., Fang, Y., & Li, J. (2018). The effect of metacognitive knowledge on mathematics performance in self-regulated learning framework-multiple mediation of self-efficacy and motivation. *Frontiers in Psychology*, *9*, 2518. https://doi.org/10.3389/fpsyg.2018.02518

Tzohar-rozen, M. (2014). Metacognition, motivation, and emotions: Contribution of self-regulated learning to solving mathematical problems. *Global Education Review*, *1*(4), 76–95. https://ger.mercy.edu/index.php/ger/article/view/63

Utami, N. S., & Fuadiyah, N. F. (2018). Tingkat kecemasan dan pengaruhnya terhadap hasil belajar siswa pada pelajaran matematika. *Jurnal Pendidikan Matematika, 4*(1), 327-335. https://doi.org/10.33654/math.v4i0.275

Vukovic, R. K., Kieffer, M. J., Bailey, S. P., & Harari, R. R. (2013). Mathematics anxiety in young children: Concurrent and longitudinal associations with mathematical performance. *Contemporary Educational Psychology*, *38*(1), 1–10. https://doi.org/10.1016/j.cedpsych.2012.09.001

Wang, Z., Rimfeld, K., Shakeshaft, N., Scho, K., & Malanchini, M. (2020). The longitudinal role of mathematics anxiety in mathematics development: Issues of gender differences and domain-specificity. *Journal of Adolescence Journal*, *80*, 220–232. https://doi.org/10.1016/j.adolescence.2020.03.003

Whyte, J., & Anthony, G. (2012). Maths anxiety: The fear factor in the mathematics classroom. *New Zealand Journal of Teachers' Work*, *9*(1), 6–15. http://www.teacherswork.ac.nz/journal/volume9_issue1/whyte.pdf

Yıldızlı, H., & Saban, A. (2016). The effect of self-regulated learning on sixth-grade Turkish students' mathematics achievements and motivational beliefs. *Cogent Education*, *19*(1). https://doi.org/10.1080/2331186X.2016.1212456

Zirk-sadowski, J., Lamptey, C., Devine, A., Haggard, & Szucs, D. (2014). Young-age gender differences in mathematics mediated by independent control or uncontrollability. *Developmental Science*, *17*(3), 366–375. https://doi.org/10.1111/desc.12126