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Self-Regulated Learning Mediates the Impact of Word-Problem-Solving Teaching Instruction in Intrinsically Motivated Students: A Moderated Mediation Analysis

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Abstract

Mathematical word problem-solving ability is important for academic success and future career opportunities. While teaching approaches focusing on word problem-solving have shown promise, the mechanisms driving their effectiveness, particularly the roles of self-regulated learning (SRL) and motivation, remain unclear. This study investigates the moderated mediation effects of motivation on word problem-solving abilities through SRL. A quasi-experimental study was conducted with 123 eighth-grade Indonesian students, divided into four classes. Two classes received word problem-solving instruction, while the others followed standard problem-solving instruction. Students' problem-solving abilities, SRL, and motivation were assessed before and after the intervention. Using the PROCESS Macro, we evaluated simple and moderated mediation effects. The findings revealed that the word problem-solving intervention significantly enhanced SRL, which in turn improved problem-solving abilities, particularly among intrinsically motivated students. This effect was not observed in extrinsically motivated students. This study provides a novel exploration of SRL as a mediator and motivation as a moderator in educational interventions, offering a comprehensive understanding of the mechanisms underlying successful problem-solving. It provides valuable insights for educational practitioners, emphasizing the importance of SRL and intrinsic motivation in promoting effective and equitable problem-solving skills.

Keywords: *Word Problem, Self-regulated learning, Motivation, Mathematics, Moderation, Mediation.*

Introduction

Mathematical problem-solving is a fundamental component of effective mathematics education, which helps students move beyond memorization to apply their knowledge in real-world situations (Phonapichat & Wongwanich, 2014; Selter et al., 2000).. The National Council of Teachers of Mathematics (NCTM, 2000) and scholars (Santos-Trigo, 2014; Verschaffel et al., 2020) emphasize the importance of developing these skills as a major goal of mathematical education.

Word problems are central to this process because they allow students to apply broad problem-solving skills in a mathematical context by precisely translating real-world circumstances into mathematical language (Daroczy et al., 2015; Schukajlow et al., 2018). Proficiency in word problem-solving is crucial for adult success and is strongly associated with employment and income potential (Hein & Smerdon, 2013; Verschaffel et al., 2020). Over the last two decades, both researchers and educators have focused on mathematical word problems, recognizing their critical role in fostering deep mathematical understanding and real-world application (Daroczy et al., 2015; Selter et al., 2000; Strohmaier et al., 2022; Verschaffel et al., 2015). Word problems provide students with abilities that extend beyond the classroom and into real-life contexts through a combination of comprehension and application (Powell & Fuchs, 2018; Selter et al., 2000; Strohmaier et al., 2022). In countries like Indonesia, improving word problem-solving is essential for future economic growth and global competitiveness, as Indonesia will enjoy the advantage of a demographic bonus by 2045.

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Considering the significance of word problem-solving skills, this study aims to explore the moderated mediation effects in the context of word problem-solving teaching interventions on problem-solving outcomes. The first aim is to examine the influence of problem-solving interventions on word problem-solving abilities, with SRL as a mediator. Secondly, we investigate whether the mediating role of SRL varies as a function of motivation, specifically whether students with intrinsic motivation benefit more from these interventions than those with extrinsic motivation. To address these research questions, we developed a moderated mediation model (see Figure 1).

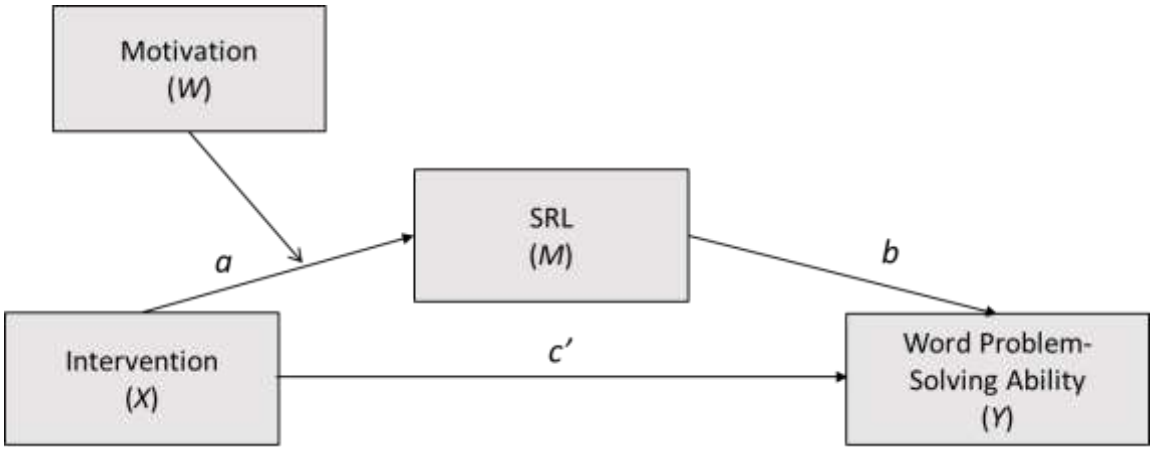

Figure 1. Conceptual Diagram of Moderated Mediation of Motivation (W) On the Relationship Between Problem-Solving Intervention (X) And Word Problem-Solving Ability (Y) Via Self-Regulated Learning (SRL). Gender And Pre-Intervention Test Scores Were Included as Covariates but Are Not Represented Here

Literature Review

Theoretical Framework

We drew on two key theoretical frameworks: Self-Regulated Learning (SRL) and Self-Determination Theory (SDT). SRL refers to a metacognitive process where individuals actively manage their thoughts, behaviors, and environment to achieve learning goals (Pintrich, 2000; Zimmerman & Schunk, 2001). The key components of SRL include self-awareness, motivation, control, and reflection, which help students set realistic goals, develop effective strategies, and persevere through obstacles. Once students master SRL skills or become independent learners, they can apply their knowledge to new situations and demonstrate adaptability and critical thinking. Prior studies suggest that possessing SRL and metacognitive skills are determinants of independent learning and problem-solving performance (Alafgani & Purwandari, 2019; Bibi & Ahmad, 2022; Cleary et al., 2021; Fadlelmula et al., 2015; Muljana et al., 2023; Pintrich, 2000; Rutherford et al., 2018; Tee et al., 2021; Zimmerman & Schunk, 2001).

Moreover, Zimmerman's SRL theory considers motivation a core component, which likely moderates the relationship between SRL and word problem-solving outcomes. Intrinsic motivation, induced by interest and enjoyment, can reinforce SRL's positive impact on problem-solving performance, whereas extrinsic motivation, driven by external rewards, may reduce this relationship (Ryan & Deci, 2000). During the forethought phase of SRL, self-motivation is important for goal setting and strategic planning, with intrinsically motivated students being more likely to set challenging goals and persist in finding solutions. In contrast, extrinsically motivated students may set less ambitious goals and use superficial strategies. While motivations influence all phases of SRL, intrinsic motivation boosts SRL's positive effect on problem-solving outcomes, which results in better outcomes.

Challenges in Word-Problem-Solving

To effectively solve mathematical word problems, both mental representation and reading comprehension skills (Boonen et al., 2016) are required. Students are instructed to translate textual information, construct

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mathematical models, and interpret solutions, which makes it much more challenging than simple arithmetic (Csíkos and Szitányi (2020). This complex process involves several steps: understanding the problem, creating a mathematical representation, solving it, and evaluating the answer within the problem context (Depaepe et al., 2015; Montague et al., 2014; Niss, 2015; Selter et al., 2000).

Furthermore, challenges in solving mathematical word problems are evident globally. While in Indonesia, prior studies (Mulyono & Hadiyanti, 2018; Riyadi et al., 2021; Sari et al., 2021) have delineated specific challenges Indonesian students encounter, such as comprehending problem statements and converting them into mathematical expressions.

Meanwhile, research on mathematical word problems, mostly observational in nature, has found the complex relationship between text comprehension and arithmetic proficiency in successful problem-solving (Akhter et al., 2015; Doorman & Van Maneen, 2008; Pongsakdi et al., 2020; Powell & Fuchs, 2018). Although observational study design could offer valuable insights, the lack of intervention studies may limit our understanding of causal relationships between teaching methods and student outcomes.

Interventions on Word-Problem-Solving Improvement

To deal with these challenges, several instructional strategies have been developed, focusing on cognitive and metacognitive processes. Cognitive approaches, such as Schema-Based Instruction (SBI) (Jitendra & Star, 2012) and Mathematics Realistic Education (Idris & Kristina Silalahi, 2016; Yuanita et al., 2018), concentrate on teaching specific problem-solving strategies and connecting mathematics to real-world contexts. Metacognitive strategies, such as "Solve It!" (Krawec et al., 2013) and IMPROVE (Mevarech, 1999), equip students with self-regulation tools to monitor and evaluate their problem-solving processes. In addition, problem-based instruction (Rudtin, 2013), collaborative learning (Solikha & Nurtamam, 2021), discovery learning (Carera, 2017), and communication-focused methods (Sabrine, 2017) have demonstrated their efficacies in improving word problem-solving skills.

Nonetheless, the mechanism underlying the relationship between problem-solving strategies, SRL, and motivation is still unclear. Scholars have suggested the importance of various non-cognitive factors in mathematical problem-solving, including self-concept, self-efficacy, anxiety, and motivation (Özcan & Eren Gümüş, 2019) and (Code, 2020). Thus, it is important to explore the potential mechanism by which a specific problem-solving strategy influences the improved word problem in mathematics among students through the influence of the strategy on self-regulated learning and motivation.

The Mediation Role of SRL and Moderator Role of Motivation

Previous research has established a close link between SRL's focus on metacognition and self-directed learning with problem-solving (Bibi & Ahmad, 2022; Code, 2020; Fadlelmula et al., 2015; Manganelli et al., 2019). Students who exhibit high levels of self-regulation will solve problems effectively because they can plan, monitor, and assess their problem-solving processes systematically. This suggests a potential mediator role of SRL in the relationship between word-problem-solving interventions and improved outcomes. Thus, the intervention's effectiveness may be boosted by high SRL levels resulting from the intervention. It is plausible that any word-problem intervention may foster greater autonomy and strategic thinking because it reinforces students to apply SRL strategies.

In addition to SRL, motivation could also play a significant role in shaping student outcomes, particularly in the context of mathematical problem-solving. Research consistently demonstrates that motivational variables are stronger predictors of achievement than intellectual abilities (Abín et al., 2020; Manganelli et al., 2019). According to the Self-Determination Theory (SDT) (Deci & Ryan, 2000; Ryan & Deci, 2000), there are three distinct motivational orientations: intrinsic, extrinsic, and amotivated. Intrinsically motivated students engage in activities for personal interest and enjoyment, leading to self-regulation and goal achievement. Extrinsically motivated students are driven by external factors like rewards or pressure, while amotivated students lack interest or value in the activity. Consequently, it is necessary to evaluate the extent

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to which the mechanism of SRL depends on students' motivational states to enhance the effectiveness of any problem-solving intervention.

Meanwhile, understanding the relationship between motivation and SRL is essential for designing effective interventions to enhance word problem-solving skills. (Schukajlow et al., 2018) highlight this need and underline the importance of integrating motivation, emotions, and beliefs into future education research. A prior study in Finland (Pongsakdi et al., 2019) found a variation in the effects of word problem enhancement (WPE), depending on students' initial motivation levels. Specifically, the WPE impacted student beliefs only among those with low initial motivation, while its effects on problem-solving performance were observed only in students with high initial motivation. However, it is important to note that this study was conducted in developed countries, and the findings may not fully apply to developing countries due to cultural differences. To date, comprehensive studies are limited to examining the complex relationship among self-regulation, motivation, and problem-solving outcomes within an experimental analytical framework.

Research Gaps and Hypothesis Formulation

Based on the aforementioned studies, there is little published research on the combined roles of SRL and motivation in word problem-solving interventions within an experimental context, especially in developing countries. The majority of research has been observational, restricting our understanding of causality. Therefore, this study will test the following hypotheses:

- Word-problem-solving abilities will be higher among students receiving word-problem-solving interventions than the standard intervention.
- SRL will mediate the relationship between intervention and problem-solving ability.
- The indirect effect of SRL on problem-solving ability will be higher for intrinsically motivated students than extrinsically motivated students.

In this study, we will control for gender and pre-intervention mathematics problem-solving scores to clarify the primary relationships between the intervention and word problem-solving outcomes. Boys typically exhibit higher confidence, enjoy the tasks more, experience more positive emotions, and show a stronger willingness to invest effort than girls when approaching math problems (Panadero, 2017; Sa'dijah et al., 2021). By controlling pre-test scores, we can isolate the effects of motivation on the mediated relationship between word-problem interventions and problem-solving performance.

Method

Design, Participants, and Procedure

A quasi-experimental design was utilized in this study with non-equivalent pre- and post-test control groups. Quasi-experimental designs involve experiments where treatment is applied to pre-existing classes rather than groups formed through random selection (Johnson & Christensen, 2000). The design was used to examine the moderated mediation effect of motivation on the relationship between word-problem interventions and problem-solving abilities, with gender and pre-intervention test scores controlled as covariates. The decision to focus on moderated mediation was based on the theoretical importance of motivation in influencing educational outcomes through SRL and the need to account for gender differences without treating them as primary moderators.

Participants were 123 eighth-grade students from a junior high school in Surabaya, Indonesia. Four classes were randomly selected from eight eighth-grade classes to ensure a balanced and representative sample.

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Two classes were randomly assigned to the teaching approach group, which focused on word problem-solving ("word problem"). The other two classes served as the control group, receiving standard problem-solving instruction ("standard"). The intervention group comprised 61 students (33 boys, 53.2%), while the control group included 62 students (34 boys, 54.8%).

Before the intervention, all participants completed a pre-test to assess their baseline problem-solving abilities and were administered a motivation scale questionnaire. The intervention and control groups followed a curriculum on linear equations with two variables, aligned with Indonesia's standard eighth-grade mathematics curriculum. The same teacher instructed both groups on five topics, conducted for five weeks in three × 45 minutes per week. The key difference between the groups was the instructional approach: the word problem-solving group was exposed to a specific word-problem-solving strategy, while the control group received standard problem-solving instruction.

To evaluate the intervention's effectiveness, both experimental and control groups completed a post-test assessing problem-solving abilities. Additionally, all participants filled out a self-regulated learning (SRL) questionnaire. The study adhered to ethical guidelines and was approved by the Institutional Review Board of Universitas Negeri Surabaya, Indonesia.

Problem-Solving Teaching Instruction Module

The teaching module on systems of linear equations with two variables, divided into five sub-topics, was conducted over five weeks, with each session lasting 3×45 minutes per week. The sub-topics included: 1) Systems of Linear Equations with Two Variables, 2) Solving Systems of Linear Equations by Elimination, 3) Solving Systems of Linear Equations by Substitution, 4) Solving Systems of Linear Equations by Mixed Method (elimination – substitution), and 5) Application of Systems of Linear Equations.

Word-problem-solving and standard problem-solving intervention or instruction share a similar structure in teaching these topics, involving a sequence of activities: introduction to learning, problem presentation, problem comprehension, solution planning, implementation, evaluation, reflection, and practice. The differences lay in the emphasis and specific activities within these structures.

The word problem-solving approach prioritizes contextual understanding by focusing on students' ability to comprehend and solve problems presented in a narrative form. This approach utilizes real-world scenarios to enhance student engagement and deepen understanding. Several strategies are employed in this study to help develop higher-order thinking skills (e.g., critical analysis and creativity), including pattern recognition, diagrammatic representation, and tabular analysis. This approach also focuses on teaching how to interpret results within the context of the problem. Students are then encouraged to perform structured reflection and gradual practice to strengthen to reinforce learning, where issues increase in difficulty over time.

In contrast, the standard or conventional problem-solving class focuses on procedural mastery, which emphasizes the systematic application of algorithms and methods, particularly substitution and elimination, to solve linear equations. This approach is denoted by a more organized problem identification and analysis process, often presenting problems more abstractly and less contextualized. The class aims to cultivate routine problem-solving skills and mechanical abilities, with an emphasis on transferring these skills to other contexts or situations rather than on additional practice with increasingly challenging problems

Instruments

Self-Regulated Learning

Self-regulated learning (SRL) was assessed using a questionnaire adapted from (Lestari & Yudhanegara, 2015) based on (Zimmerman & Moylan, 2009) SRL framework. This 30-item instrument employed a 4-point Likert scale (1 = never, 4 = always) to measure response frequency. Negative items were reverse-

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scored. An example is, "I can adhere to a consistent study routine. Table 1 displays the indicators and their descriptors of SRL and motivation scales.

Table 1. Indicators of Self-Regulated Learning and Motivation Scales

Variable	Indicator	Descriptor
Self-Regulated Learning	1. Goal Orientation	1.1. Setting learning goal
		1.2. Planning learning strategies
	2. Self-motivation beliefs	2.1. Belief in achieving the best outcomes
		2.2. Belief in overcoming obstacles
	3. Self-perceived ability	3.1. Ability to implement planned learning strategies
		3.2. Ability to direct learning interest
	4. Self-concept	4.1. Attitude towards the lessons (subjects)
		4.2. Perception about the field they are pursuing
	5. Self-monitoring and evaluation	5.1. Capable of directing their learning activities
		5.2. Capable of assessing the effectiveness of their learning
		5.3. Capable of objectively evaluating their quality
	6. Self-Attribute	6.1. Capable of identifying the factors contributing to their learning success
Motivation	1. Desire and motivation to learn	1.1. Possesses a strong desire to learn
		1.2. Exhibit a genuine interest in the learning process
	2. Presence of learning needs	2.1. Recognizes the necessity of acquiring knowledge
		2.2. Demonstrates a commitment to fulfilling assignments given by teachers at school
	3. Aspiration to achieve future goals	3.1. Actively pursues steps to fulfill the ambitions
		3.2. Holds clear aspirations for the future
	4. Recognition of Learning	4.1. Rewards, praise, and punishment in learning
	5. Engaging Learning Activities	5.1. Remains engaged during the learning process
		5.2. Actively participates in learning activities with enthusiasm
	6. Supportive Learning Environment	6.1. A supportive and comfortable environment for effective learning

Content validity was established through expert review of item relevance, clarity, and comprehensiveness. Expert feedback informed item revision to ensure accurate construct representation. Construct validity and reliability were examined using a pilot study with 31 non-intervention/control group students. Pearson's product-moment correlation assessed construct validity, with items having $|r| > 0.355$ considered valid. Cronbach's alpha, exceeding 0.6, indicated acceptable reliability (Field, 2017). The pilot study results showed Pearson correlation coefficients ranging from -0.049 to 0.547 and a Cronbach's alpha of 0.852. Five items were removed, resulting in a 25-item. This revised scale was used in the main study to measure SRL.

Motivation

Motivation was assessed using a modified version of the Motivated Strategies for Learning Questionnaire (Duncan & McKeachie, 2005), adapted from (Lestari & Yudhanegara, 2015) and aligned with Self-Determination Theory (SDT) (Ryan & Deci, 2000). The questionnaire comprised 40 items, distributed

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between intrinsic and extrinsic motivation, with participants responding on a 4-point Likert scale. For example, an intrinsic motivation item was, " I am trying my best to complete the math assignment given by the teacher accurately and correctly," while an extrinsic motivation item was, "I am more likely to engage in mathematics study when there is an upcoming quiz or exam." Higher intrinsic motivation scores indicated greater motivation levels. Students were categorized as intrinsically motivated if they had higher intrinsic motivation scores. All negatively worded items were reverse-scored.

Similar to the validity and reliability assessment of the SRL scale, content validity for the motivation scale was established through expert review. Construct validity was assessed using Pearson's product-moment correlation, with items having $|r| > 0.355$ considered valid. Six items were removed, resulting in a 34-item scale. The scale demonstrated strong reliability with a Cronbach's alpha of 0.852.

Word-Problem-Solving Test

A mathematical word problem-solving instrument was specifically developed to assess students' problem-solving abilities. This instrument consisted of four open-ended questions directly aligned with the teaching module's content. It evaluated students' implementation of the four problem-solving stages outlined in Table 2. A marking scheme was employed, assigning scores from 1 to 5 for each question, with a maximum possible score of 20.

The instrument was developed according to the (Schoenfeld, 1985) framework and adapted to meet the standards of the Indonesian curriculum. To ensure content validity, two experts in mathematics education conducted an analysis. One expert confirmed the overall quality of the instrument, while the other recommended minor revisions, such as adjustments to unit conversions and equation formatting.

Construct validity was established through Pearson's item-total correlation analysis. Item-total correlation coefficients ranged from 0.699 to 0.823. Furthermore, the instrument demonstrated satisfactory reliability, with a Cronbach's alpha of 0.75, indicating robust construct validity and internal consistency.

Table 2. Assessment Rubric for Mathematical word problem-solving

Stage	Indicator	Response Level Descriptors	Score
1. Understanding the Problem	Identifying and documenting relevant key information and carefully analyzing the problem's requirements as factual knowledge to ensure a thorough understanding of the problem.	The problem is not understood, or the answer does not exist.	1
		The problem's requirements are not properly considered.	2
		Understands and considers the problem's requirements but lacks completeness.	3
		Understands and considers the problem's requirements.	4
		Thoroughly understands and considers the problem's requirements.	5
2. Planning the Solution	Comprehending the core issue through conceptual understanding, which enables the student to articulate the problem as a structured plan for	No problem-solving plan is made	1
		The problem-solving plan is made but is inaccurate.	2

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	problem-solving, necessary to achieve a solution	The problem-solving plan is correct but leads to an incorrect answer	3
		The problem-solving plan is correct but cannot be fully executed.	4
		The problem-solving plan is correct and leads to the correct answer	5
3. Executing the Planned Solution	Performing calculations according to the problem-solving plan, employing appropriate calculation strategies as procedural knowledge to solve the problem through accurate and systematic steps.	The solution plan is not executed.	1
		The solution plan is executed but not according to the correct procedure	2
		A specific procedure is used, leading to the correct answer	3
		A correct procedure is used, but there are errors in the calculation.	4
		The correct procedure is used, and the result is correct.	5
4. Reviewing the Solution	Interpreting the calculation results to verify their accuracy serves as metacognitive knowledge for ensuring the correctness of the problem-solving process.	No review or additional explanation is provided.	1
		A review is conducted, but it is incomplete.	2
		The review is conducted to check the correctness of the process but does not yield a result.	3
		The review is conducted to check the correctness of the process, but it is not comprehensive.	4
		A thorough review is conducted, and the complete correctness of the process is confirmed	5

Data Analysis

In the data analysis phase, descriptive statistics were presented for all measured variables to provide an overview of the dataset. Next, bivariate correlations between the main outcome measures and associative factors were tested using Pearson correlation analysis. Further evaluation of hypotheses 1, 2, and 3 were conducted using bias-corrected bootstrap analyses (using 5000 bootstrap samples) with the PROCESS macros for SPSS, developed by (Hayes, 2018). This bootstrapping method helps mitigate issues related to statistical power that arise from non-normal distributions (Mackinnon et al., 2000). The effects were significant when the 95% percentile CIs did not include the value of zero (Hayes, 2018). Considering that no template represents the full model, we tested hypotheses in three stages.

First, we assessed the effects of teaching instruction or intervention on word problem-solving abilities, both directly and indirectly through SRL, using simple mediation analysis (template model #4), as described by

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(Hayes, 2018). Second, we assessed the extent to which the effect of craving on SRL was moderated by motivation. Finally, we combined the moderation and mediation results by estimating the conditional indirect effects of the intervention on word problem-solving abilities through SRL as a function of motivation, using the moderated mediation approach (template model #7) (Hayes, 2018). Gender and pre-intervention word problem-solving abilities were used as covariates in the path between the intervention and word problem-solving abilities (*c*'-path) (see Figure 2). The criterion for statistical significance was $p < 0.05$. The general equations for the statistical diagram of the moderated mediation model depicted in Figure 2 are provided as follows:

$$M = i_M + a_1X + a_2W + a_3XW + e_M \quad (1)$$

$$Y = i_Y + c_1'X + c_2'X + c_3'X + bM + e_Y \quad (2)$$

Where i_M and i_Y are regression constants, e_M and e_Y are errors in the estimation of *M* and *Y*, respectively, and a_1, a_2, c_3, b, c_1', c_1', and c_3' are the regression coefficients given to the antecedent variables in the model in the estimation of the consequents.

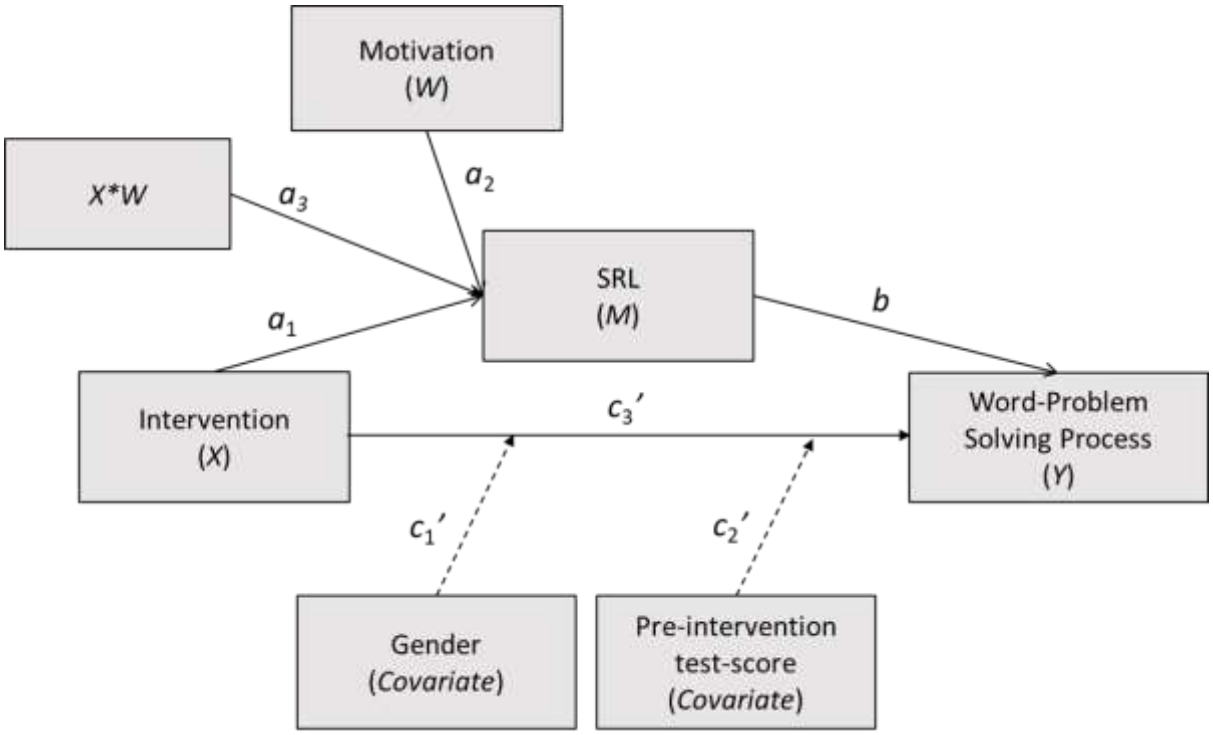

Figure 2. Statistical Diagram of Moderated Mediation of Motivation (*W*) On the Relationship Between Problem-Solving Intervention (*X*) And Word Problem-Solving Ability (*Y*) Via Self-Regulated Learning (SRL) (*M*). Model A-Path Denotes $X \rightarrow M$; Model *B*-Path Denotes $M \rightarrow Y$, And Model C' Path Denotes Direct Effect $X \rightarrow Y$. Covariates Were Controlled on the *C*'-Path Only.

Results

Descriptive Statistics and Correlation among the Variables Under Study

Table 3 shows descriptive statistics of all outcome variables, which reveals improvements in problem-solving processes and SRL for both teaching methods. However, the word problem-solving intervention significantly enhanced SRL and problem-solving abilities, especially among intrinsically motivated students. This indicates a possible interaction between intervention and motivation.

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Independent *t*-tests assessed problem-solving ability at pre-intervention to ensure baseline equivalence between groups. Results indicated no significant differences between groups on the score (t (121) =1.62, p = 0.10). This equivalence at baseline strengthens the causal inference that subsequent differences can be attributed to the intervention.

Table 3. Descriptive Statistics of Outcome Variables

Intervention (*X*)	Motivation (*W*)		Pre-Intervention Test Score (Covariate)	Post- Intervention Problem-Solving Ability (*Y*)	SRL (*M*)
Word Problem-Solving	Intrinsic	Mean	11.88	14.89	71.59
		SD	1.453	1.790	7.205
Standard Problem-Solving	Extrinsic	Mean	10.97	12.79	67.24
		SD	1.765	1.766	5.768

The correlations between the observed variables are depicted in Table 4. Gender had a significant association with problem-solving ability both pre- and post-intervention although did not demonstrate a significant correlation with other variables. Intrinsic motivation was positively correlated with higher SRL, pre-test, and post-test scores.

Table 4. Correlation among all Variables Under Studied

	Variable	**1**	**2**	**3**	**4**	**5**	**6**
1	Intervention	-	-0.02	0.01	0.32***	0.15	0.51***
2	Gender		-	-0.03	0.10	0.30**	0.28**
3	Motivation			-	-0.28**	-0.21*	-0.26**
4	SRL				-	0.20*	0.39**
5	Pre-intervention score					-	0.85***
6	Problem-solving abilities						-

Notes. Significant at * p < 0.05, ** p < 0.01, *** p < 0.001

Mediation Analysis

Using model 4 from the PROCESS Macro procedure for SPSS (Hayes, 2018), the equation representing a simple mediation analysis to estimate the coefficient of each path in ordinary least square (OLS) regression is provided in Equation (3):

$$\text{Word Problem-Solving ability} = \text{constant} + c'(\text{intervention}) + b(\text{SRL}) + \text{covariates} + \text{error} \quad (3)$$

As depicted in path c in Figure 3 (total effect), problem-solving abilities were higher among students in the word problem-solving intervention, confirming hypothesis 1. Path a in Figure 3 indicates that the intervention was positively associated with SRL, with students reporting higher SRL post-intervention. SRL was also positively related to problem-solving abilities (path b), and the direct effect of the intervention on problem-solving (path c') was statistically significant.

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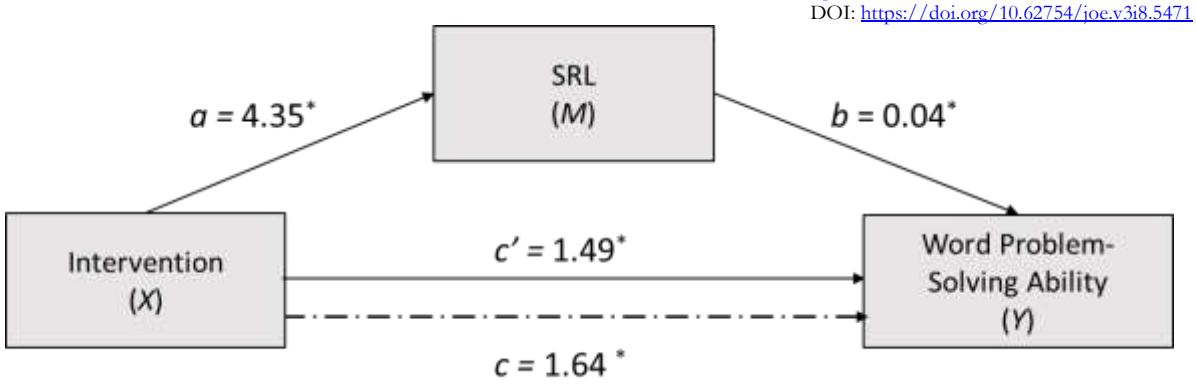

Figure 3. Path Coefficients for Simple Mediation Analysis.

Note: The Dotted Line Denotes the Effect of The Intervention on Word Problem-Solving Abilities When SRL Is Not Included as A Mediator (Total Effect). Gender And Pre-Intervention Tests Were Included as Covariates but Are Not Represented Here.

The model explained 10.2% of the variance in SRL ($R^2 = 0.10$) and 90% in problem-solving abilities ($R^2 = 0.90$), combining the intervention's and SRL's effects. For hypothesis 2, the estimate of the indirect effect of intervention on word problem-solving abilities, quantified as the product of the coefficient estimating SRL from the intervention (path *a* in Figure 3) and the coefficient estimating word problem-solving abilities from SRL controlling for the intervention (path *b* in Figure 3). It reveals a significant positive indirect effect of the intervention on problem-solving through SRL (effect: 0.15, 95% CI: 0.05 to 0.29) using 5,000 bootstrap samples. This supports partial mediation since the direct effect remained significant after accounting for SRL ($c' = 1.49$, $p < 0.001$).

Moderation of the Effect of Intervention on Word Problem-Solving Abilities by Motivation

To test for the moderation of the effect of the intervention on word problem-solving abilities by motivation, we estimated an OLS regression model as shown in Equation (4) (along with gender and pre-intervention test scores as controls discussed above):

$$\text{SRL} = \text{constant} + a_1(\text{intervention}) + a_2(\text{motivation}) + a_3(\text{intervention} \times \text{motivation}) + \text{covariates} + \text{error} \quad (4)$$

his analysis revealed that the effect of the intervention on SRL was dependent on motivation (see Table 5, $a_3 = -4.62$, $p = 0.04$), with the interaction accounting for 2.8% of the variance in SRL, which is significant ($F(1, 119) = 4.20$, $p = 0.04$).

Table 5. Model Coefficients for the Moderated Mediation Model

			Model *a*-path				Model *b*/*c*'path		
			Dependent = SRL				Dependent = Problem-Solving Abilities		
	Variable		coeff	SE	*p*		coeff	SE	*p*
X	Intervention	a_1	7.09	1.72	< 0.001	c_3'	1.49	0.13	<0.001
M	SRL					*b*	0.04	0.01	<0.001
W	Motivation	a_2	-1.70	1.58	0.28		---	---	---
X × *W*	Intervention × Motivation	a_3	-4.62	2.25	0.04	---	---	---	---

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Cov 1	Gender	---	---	---	---	c_1'	0.88	0.04	<0.001
Cov 2	Pre-Score	---	---	---	---	c_2'	0.66	0.70	0.34
Constant		i_M	68.23	1.21	< 0.001	i_Y	-0.29	1.06	0.78
			$R^2 = 0.21$				$R^2 = 0.90$		
			$F(3, 119) = 10.68, p < 0.001$				$F(4, 118) = 250.64, p < 0.001$		

Note: coeff = Coefficient, SE = Standard Error

Moderated Mediation Analysis

The simple mediation analysis provided evidence of a positive indirect effect of the intervention on word problem-solving abilities through SRL—with word problem-solving intervention associated with higher SRL, which in turn was linked to improved mathematical word problem-solving. The moderation analysis further indicated that the effect of the intervention on SRL depended on motivation, with the impact of intervention being greater among intrinsically motivated students. Together, these findings suggest that the "mediation is moderated", meaning the indirect effect of the intervention on word problem-solving abilities through SRL depended on motivation.

Using Hayes' PROCESS Model 7 with adjustment in the covariate matrix (c' path), the conditional indirect effect of the intervention through SRL was estimated, with bootstrap estimates for 95% bias-corrected CIs.

The conditional indirect effect of the intervention on word problem-solving through SRL is the product of the conditional effect of the intervention on SRL as a function of motivation ($a_1 + a_3$motivation; from Equation 4) and the effect of SRL on word problem-solving abilities controlling for intervention (b in Equation 3). The point estimate for the conditional indirect effect of the intervention on word problem-solving ability through SRL at either intrinsic or extrinsic motivation is shown in Figure 4 and Table 5.

For intrinsically motivated students, the indirect effect was significant (0.25, 95% CI: 0.07 to 0.49). However, for extrinsically motivated students, the effect was smaller and not statistically significant (0.088, 95% CI: -0.017 to 0.195), suggesting the intervention is more effective when driven by intrinsic motivation. The index of moderated mediation was also significant, with an index value of -0.1636 and a 95% confidence interval between -0.421 and -0.004. This result confirms hypothesis 3 that the type of motivation moderates self-regulation's mediation effect on problem-solving skills.

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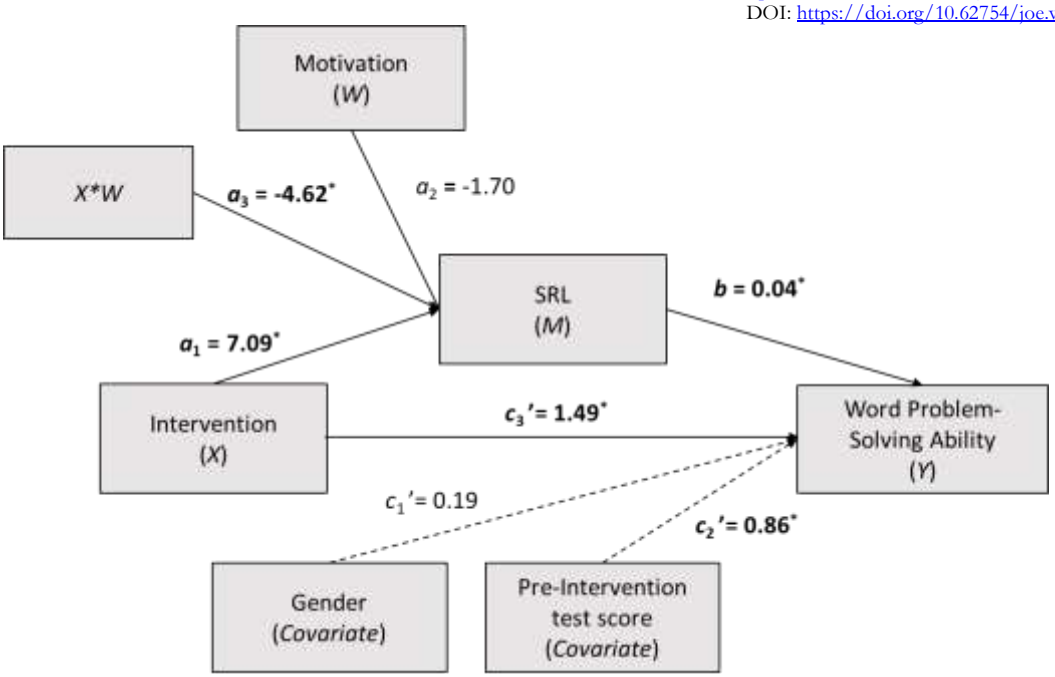

Figure 4. Path Coefficients in Moderated Mediation Model. Bold Font And * Denote the Significance of The Effect At P<0.05. Gender And Pre-Intervention Test Score Were Included as Covariates but Are Not Represented Here.

Table 6. Conditional Direct and Indirect Conditional Direct and Indirect Effects for the Conditional Process Model in Figure 4

W	Indirect Effect			Direct Effect			
	Intervention (*X*) → SRL (*M*) → Problem-Solving (*Y*)			Intervention (*X*) → Problem-Solving (*Y*)			
	Effect	Boot SE	95% CI Boot	Effect	SE	*t*	*P*
Intrinsic	0.25	0.11	0.068 - 0.490	1.49	0.13	11.43	< 0.001
Extrinsic	0.09	0.34	-0.017 - 0.195				

Discussion

After the intervention, the results demonstrate significantly improved word problem-solving abilities, confirming hypothesis one. The indirect effect suggests that part of the intervention's impact is mediated by improvements in SRL, supporting the second hypothesis. Moreover, the moderated mediation effect indicates that SRL benefits problem-solving more for intrinsically motivated students than extrinsically motivated ones, supporting hypothesis 3. We provide a detailed discussion as follows.

Mediation by Self-Regulation

This study found that SRL significantly mediates the relationship between word problem-solving intervention and word problem-solving ability. This finding supports hypothesis 2 and accords with Zimmerman's Cyclical Phases Model of SRL. The intervention, designed to enhance word problem-solving abilities, targeted critical components within the model's three phases: forethought, performance, and self-reflection. In the forethought phase, the intervention may have facilitated the development of necessary cognitive skills for effectively planning their word problem-solving approach. Then, in the performance phase, the intervention may have equipped students with self-monitoring techniques and self-control strategies to sustain focus and motivation during problem-solving. Finally, during the self-reflection phase, the intervention may have encouraged students to evaluate their problem-solving performance, identify

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areas for improvement, and adjust their strategies for future tasks based on these reflections. This result corroborates prior research connecting SRL with academic achievement (Cleary et al., 2021; Fadlelmula et al., 2015; Muljana et al., 2023; Rutherford et al., 2018; Tee et al., 2021). However, most of these studies did not evaluate the role of SRL as a mediator, except for (Bibi & Ahmad, 2022). In particular, (Bibi & Ahmad, 2022) focused on the mediation role of specific SRL strategies (elaboration and critical thinking) with the antecedent goal orientation, instead of a teaching or education intervention. However, our study did not differentiate each component of the SRL construct, which needs further investigation. Furthermore, a significant mediating role of SRL in this study suggests that the intervention's effectiveness primarily resulted from its ability to foster self-regulatory skills. It seems that the intervention contributed to the improved outcomes by empowering students to be responsible for their learning and actively manage their problem-solving processes.

Moderated Mediation Effect of Motivation on Word Problem-Solving through SRL

In addition to the significant mediating role of self-regulated learning (SRL), we observed a significant conditional indirect effect of motivation, which supports hypothesis 3. In particular, the effectiveness of the word problem-solving teaching intervention was more pronounced among intrinsically motivated students than those with extrinsic motivation. This finding confirms the Self-Determination Theory (SDT) principle that intrinsic motivation driven by inherent interest and enjoyment, foster deeper engagement and more effective learning strategies (Ryan & Deci, 2000). Nonetheless, we could not demonstrate a significant direct effect of motivation on SRL, indicating that motivation alone may not directly drive SRL behaviors. Instead, the effectiveness of SRL appears to be significantly improved when motivation interacts with targeted interventions. This finding contradicts earlier studies showing a positive association between academic motivation and SRL (Mahmoodi, 2014; Manganelli et al., 2019; Özcan, 2016), yet is in line with (Tee et al., 2021)'s study, which found that motivational regulation alone is inadequate to initiate proactive learning. Instead, positive behaviors and applying appropriate cognitive strategies, as provided by the intervention, are necessary to facilitate the learning process.

Within Zimmerman's Cyclical Phases Model of SRL, motivation serves as a key determinant influencing the development and sustainability of SRL, especially intrinsic motivation. Intrinsic motivation profoundly impacts a student's decision-making process throughout the forethought phase. Intrinsically motivated students who believe in their abilities are more likely to set ambitious goals and formulate them effectively. Conversely, lower-motivation students may be less likely to engage in these preparatory activities. During the performance phase, students who are intrinsically motivated and have strong desire are more likely to maintain focus, persevere through challenges, and utilize self-regulation strategies effectively. Lastly, during the Reflection phase, students who attribute their successes to internal factors such as effort and ability are more likely to sustain or increase their motivation for subsequent tasks and continue using SRL strategies. On the opposite, those crediting failures to external factors, like task difficulty or luck, may exhibit reduced motivation to engage in SRL. Although intrinsic motivation solely did not directly enhance SRL, its combination with a well-structured intervention (i.e., word problem-solving teaching approach) significantly improved students' engagement in the SRL process.

On the other hand, students motivated by extrinsic factors such as external rewards or pressures, may engage in the SRL process with less depth, focusing more on achieving the minimum requirements over truly mastering the learning contents. For these students, hence, the intervention's effectiveness is less evident. Therefore, designing interventions that teach problem-solving strategies and promote intrinsic motivation may improve students' academic outcomes.

Implications

This study offers valuable insights theoretically and practically into the relationship between self-regulated learning (SRL), motivation, and educational interventions, which emphasizes the importance of considering cognitive and non-cognitive factors. Our findings extend previous work (Abín et al., 2020; Pongsakdi et al., 2019) by introducing SRL as a mediator and motivation as a moderator in evaluating interventions. The results corroborate self-determination theory, which posits the importance of intrinsic motivation for

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optimal learning (Ryan & Deci, 2000). This also accords with Zimmerman's SRL model, that motivation acts a driving force affecting the effectiveness of SRL on targeted academic outcomes across all cyclical phases (Zimmerman & Moylan, 2009; Zimmerman & Schunk, 2001).

Practically, the findings highlight the need for interventions that address both SRL and motivation. To improve students' problem-solving abilities, educational practitioners should promote self-awareness, goal setting, planning, monitoring, and reflection. Moreover, it is important to create learning environments that stimulate intrinsic motivation, such as providing opportunities for choice, autonomy, and mastery experiences. As students may possess different motivational profile, the design of interventions should be tailored to ensure them develop strong problem-solving abilities, emphasizing more effective and equitable educational programs.

Limitations and Future Research Directions

Several limitations of the current study should be acknowledged. First, its generalizability may be restricted to different context because the sample was recruited from a specific population, namely a secondary school in Indonesia. Second, as we relied on self-report measures to assess SRL and motivation, it may raise social desirability bias. Also, assessment at pre-and post-intervention may not have a complete understanding of how SRL and motivation change throughout the intervention process, which warrants assessment for multiple points (i.e., longitudinal study design). Future research should investigate the moderated mediation models in various educational settings to validate their generalizability and explain whether any specific context affect the outcomes.

Furthermore, in terms of intervention content, it is important to design the intervention by including specific strategies that also target improved SRL to enhance problem-solving outcomes (Lavasani et al., 2011; Martinek & Kipman, 2016; Tavakolizadeh & Ebrahimi-Qavam, 2011). By addressing the study's limitations and broadening the scope of future research, a contribution to a more comprehensive understanding of the factors influencing problem-solving success and informing educational stakeholders about developing effective educational practices is expected.

Conclusion

In sum, our study shows empirical evidence for the complex relationship (i.e., moderated mediation) among intervention, self-regulated learning (SRL), and motivation in improving problem-solving abilities, which confirms all proposed hypotheses. The findings demonstrate that word problem-solving instruction has a more significant impact on improving students' problem-solving abilities than standard intervention with SRL, which significantly mediated this relationship. Besides, the study highlights the moderating role of motivation, indicating that the intervention's effectiveness was particularly obvious among students with intrinsic motivations.

Our study underscores the importance of designing a comprehensive approach to improving problem-solving skills by integrating cognitive and metacognitive abilities while also simultaneously considering students' motivational profiles. As a result, students will build a strong understanding of mathematical concepts and develop problem-solving skills beyond the classroom.

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References

Abín, A., Núñez, J. C., Rodríguez, C., Cueli, M., García, T., & Rosário, P. (2020). Predicting Mathematics Achievement in Secondary Education: The Role of Cognitive, Motivational, and Emotional Variables. Frontiers in Psychology, 11, 876. https://doi.org/10.3389/fpsyg.2020.00876

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Akhter, N., Akhtar, M., & Abaidullah, M. (2015). The Perceptions of High School Mathematics Problem Solving Teaching Methods in Mathematics Education. Bulletin of Education and Research, 37(1), 55–77.

Alafgani, M., & Purwandari, E. (2019). Self-efficacy, academic motivation, self-regulated learning and academic achievement. Jurnal Psikologi Pendidikan Dan Konseling: Jurnal Kajian Psikologi Pendidikan Dan Bimbingan Konseling, 5(2), 104. https://doi.org/10.26858/jppk.v5i2.10930

Bibi, A., & Ahmad, M. (2022). Goal Orientations, Self-Regulated Learning Strategies and Problem-Solving: A Mediational Analysis. Pertanika Journal of Social Sciences and Humanities, 30(3), 949–976. https://doi.org/10.47836/pjssh.30.3.02

Boonen, A. J. H., de Koning, B. B., Jolles, J., & van der Schoot, M. (2016). Word Problem Solving in Contemporary Math Education: A Plea for Reading Comprehension Skills Training. Frontiers in Psychology, 7(February), 1–10. https://doi.org/10.3389/fpsyg.2016.00191

Carera, R. (2017). Upaya Meningkatkan Kemampuan Menyelesaikan Soal Cerita Matematika Melalui Model Discovery Learning. [Efforts to Improve Word Problem-Solving Abilities through Discovery Learning Model] [Dissertation]. Universitas Islam Negeri Syarif Hidayatullah.

Cleary, T. J., Slemp, J., & Pawlo, E. R. (2021). Linking student self-regulated learning profiles to achievement and engagement in mathematics. Psychology in the Schools, 58(3), 443–457. https://doi.org/10.1002/pits.22456

Code, J. (2020). Agency for Learning: Intention, Motivation, Self-Efficacy and Self-Regulation. Frontiers in Education, 5, 19. https://doi.org/10.3389/feduc.2020.00019

Csíkos, C., & Szitányi, J. (2020). Teachers' pedagogical content knowledge in teaching word problem solving strategies. ZDM, 52(1), 165–178. https://doi.org/10.1007/s11858-019-01115-y

Daroczy, G., Wolska, M., Meurers, W. D., & Nuerk, H. C. (2015). Word problems: A review of linguistic and numerical factors contributing to their difficulty. Frontiers in Psychology, 6(APR), 1–13. https://doi.org/10.3389/fpsyg.2015.00348

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry, 11(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Depaepe, F., De Corte, E., & Verschaffel, L. (2015). Students' Non-realistic Mathematical Modeling as a Drawback of Teachers' Beliefs About and Approaches to Word Problem Solving. In B. Pepin & B. Roesken-Winter (Eds.), From beliefs to dynamic affect systems in mathematics education (pp. 137–156). Springer International Publishing. https://doi.org/10.1007/978-3-319-06808-4_7

Doorman, M., & Van Maneen, J. (2008). A historical perspective on teaching and learning calculus. Australian Senior Mathematics Journal, 22(2), 4–14.

Duncan, T. G., & McKeachie, W. J. (2005). The Making of the Motivated Strategies for Learning Questionnaire. Educational Psychologist, 40(2), 117–128. https://doi.org/10.1207/s15326985ep4002_6

Fadlelmula, F. K., Cakiroglu, E., & Sungur, S. (2015). Developing a Structural Model on the Relationship among Motivational Beliefs, Self-Regulated Learning Strategies, and Achievement in Mathematics. International Journal of Science and Mathematics Education, 13(6), 1355–1375. https://doi.org/10.1007/s10763-013-9499-4

Field, A. (2017). Discovering Statistics Using IBM SPSS Statistics. SAGE Publications.

Hayes, A. F. (2018). Introduction to Mediation, Moderation, and Conditional Process: A Regression-Based Approach. The Guilford Press.

Hein, V., & Smerdon, B. (2013). Predictors of postsecondary success. American Institutes for Research. American Institute for Research.

Idris, I., & Kristina Silalahi, D. (2016). Penerapan Pendekatan Pendidikan Matematika Realistik Indonesia (PMRI) untuk Meningkatkan Kemampuan Penyelesaian Soal Cerita pada Kelas VII A SMP UTY [Implementation of Mathematics Realism to Improve Problem-Solving Abilities among 7th Grade Students]. Jurnal EduMatSains, 1(1), 73–82.

Jitendra, A. K., & Star, J. R. (2012). An exploratory study contrasting high- and low-achieving students' percent word problem solving. Learning and Individual Differences, 22(1), 151–158. https://doi.org/10.1016/j.lindif.2011.11.003

Johnson, B., & Christensen, L. (2000). Educational research: Quantitative and qualitative approaches. Allyn & Bacon.

Krawec, J., Huang, J., Montague, M., Kressler, B., & Melia De Alba, A. (2013). The Effects of Cognitive Strategy Instruction on Knowledge of Math Problem-Solving Processes of Middle School Students With Learning Disabilities. Learning Disability Quarterly, 36(2), 80–92. https://doi.org/10.1177/0731948712463368

Lavasani, M. G., Mirhosseini, F. S., Hejazi, E., & Davoodi, M. (2011). The Effect of Self-regulation Learning Strategies Training on the Academic Motivation and Self-efficacy. Procedia - Social and Behavioral Sciences, 29, 627–632. https://doi.org/10.1016/j.sbspro.2011.11.285

Lestari, K. E., & Yudhanegara, M. R. (2015). Penelitian Pendidikan Matematika [Research on Mathematics Education]. Refika Aditama.

Mackinnon, D. P., Krull, J. L., & Lockwood, C. M. (2000). Equivalence of the Mediation, Confounding and Suppression Effect. Prevention Science, 1(4), 173–181. https://doi.org/10.1259/0007-1285-62-742-921

Mahmoodi, M. H. (2014). Self-Regulated Learning (SRL), Motivation and Language Achievement of Iranian EFL Learners. Procedia - Social and Behavioral Sciences, 98, 1062–1068.

Manganelli, S., Cavicchiolo, E., Mallia, L., Biasi, V., Lucidi, F., & Alivernini, F. (2019). The interplay between self-determined motivation, self-regulated cognitive strategies, and prior achievement in predicting academic performance. Educational Psychology, 39(4), 470–488. https://doi.org/10.1080/01443410.2019.1572104

Martinek, D., & Kipman, U. (2016). Self-determination, Self-efficacy and Self-regulation in School: A Longitudinal Intervention Study With Primary School Pupils. Sociology Study, 6(2). https://doi.org/10.17265/2159-5526/2016.02.005

Mevarech, Z. R. (1999). Effects of Metacognitive Training Embedded in Cooperative Settings on Mathematical Problem Solving. The Journal of Educational Research, 92(4), 195–205. https://doi.org/10.1080/00220679909597597
Montague, M., Krawec, J., Enders, C., & Dietz, S. (2014). The effects of cognitive strategy instruction on math problem solving of middle-school students of varying ability. Journal of Educational Psychology, 106(2), 469–481. https://doi.org/10.1037/a0035176
Muljana, P. S., Dabas, C. S., & Luo, T. (2023). Examining the relationships among self-regulated learning, homework timeliness, and course achievement: A context of female students learning quantitative topics. Journal of Research on Technology in Education, 55(2), 143–162. https://doi.org/10.1080/15391523.2021.1936703
Mulyono, & Hadiyanti, R. (2018). Analysis of mathematical problem-solving ability based on metacognition on problem-based learning. Journal of Physics: Conference Series, 983, 012157. https://doi.org/10.1088/1742-6596/983/1/012157
NCTM. (2000). Principles and Standards—National Council of Teachers of Mathematics. https://www.nctm.org/Standards-and-Positions/Principles-and-Standards/
Niss, M. (2015). Prescriptive Modelling – Challenges and Opportunities. In G. A. Stillman, W. Blum, & M. Salett Biembengut (Eds.), Mathematical Modelling in Education Research and Practice (pp. 67–79). Springer International Publishing. https://doi.org/10.1007/978-3-319-18272-8_5
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 in Science and Technology, 47(3), 408–420. https://doi.org/10.1080/0020739X.2015.1080313
Özcan, Z. Ç., & Eren Gümüş, A. (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
Panadero, E. (2017). A Review of Self-regulated Learning: Six Models and Four Directions for Research. Frontiers in Psychology, 8, 422. https://doi.org/10.3389/fpsyg.2017.00422
Phonapichat, P., & Wongwanich, S. (2014). Effects of Using K-N-W-S on Mathematical Problem-reading Ability Development among Elementary School Students. Procedia - Social and Behavioral Sciences, 116, 5081–5084. https://doi.org/10.1016/j.sbspro.2014.01.1077
Pintrich, P. R. (2000). The Role of Goal Orientation in Self-Regulated Learning. In Handbook of Self-Regulation (pp. 451–502). Elsevier. https://doi.org/10.1016/B978-012109890-2/50043-3
Pongsakdi, N., Kajamies, A., Veermans, K., Lertola, K., Vauras, M., & Lehtinen, E. (2020). What makes mathematical word problem solving challenging? Exploring the roles of word problem characteristics, text comprehension, and arithmetic skills. ZDM - Mathematics Education, 52(1), 33–44. https://doi.org/10.1007/s11858-019-01118-9
Pongsakdi, N., Laakkonen, E., Laine, T., Veermans, K., Hannula-Sormunen, M. M., & Lehtinen, E. (2019). The Role of Beliefs and Motivational Variables in Enhancing Word Problem Solving. Scandinavian Journal of Educational Research, 63(2), 179–197. https://doi.org/10.1080/00313831.2017.1336475
Powell, S. R., & Fuchs, L. S. (2018). Effective Word-Problem Instruction: Using Schemas to Facilitate Mathematical Reasoning. Teaching Exceptional Children, 51(1), 31–42. https://doi.org/10.1177/0040059918777250
Riyadi, R., Syarifah, T. J., & Nikmaturrohmah, P. (2021). Profile of Students' Problem-Solving Skills Viewed from Polya's Four-Steps Approach and Elementary School Students. European Journal of Educational Research, 10(4), 1625–1638. https://doi.org/10.12973/eu-jer.10.4.1625
Rudtin, N. A. (2013). Penerapan Langkah Polya Dalam Model Problem Based Instruction Untuk Meningkatkan Kemampuan Siswa Menyelesaikan Soal Cerita Persegi Panjang. Jurnal Elektronik Pendidikan Matematika Tadulako, 01(01), 18–33.
Rutherford, T., Buschkuehl, M., Jaeggi, S. M., & Farkas, G. (2018). Links between achievement, executive functions, and self-regulated learning. Applied Cognitive Psychology, 32(6), 763–774. https://doi.org/10.1002/acp.3462
Ryan, R. M., & Deci, E. L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being. American Psychologist.
Sabrine, N. (2017). Upaya Meningkatkan Kemampuan Komunikasi Matematis dalam Penyelesaian Soal Cerita Materi Kesebangunan dan Kekongruenan melalui Penerapan Model Pembelajaran Reflektif Kelas IX di SMP Ananda Islamic School. Universitas Negeri Jakarta.
Sa'dijah, C., Murtafiah, W., Anwar, L., Nurhakiki, R., & Cahyowati, E. T. D. (2021). Teaching Higher Order Thinking Skills in Mathematics Classroom: Gender Differences. Journal on Mathematics Education, 12(1), 159–180. https://doi.org/10.22342/jme.12.1.13087.159-180
Santos-Trigo, M. (2014). Problem Solving in Mathematics Education. In Encyclopedia of Mathematics Education (pp. 496–501). Springer Netherlands. https://doi.org/10.1007/978-94-007-4978-8_129
Sari, I. K., Nasriadi, A., Agustiani, R., & Nursalim, R. (2021). Analysis of Students' Mathematical Problem-Solving Skills. Journal of Hunan University, 48(9), 280–289.
Schoenfeld, A. H. (1985). Mathematical problem solving. Academic Press Inc.
Schukajlow, S., Kaiser, G., & Stillman, G. (2018). Empirical research on teaching and learning of mathematical modelling: A survey on the current state-of-the-art. ZDM - Mathematics Education, 50(1–2), 5–18. https://doi.org/10.1007/s11858-018-0933-5
Selter, C., Verschaffel, L., Greer, B., & de Corte, E. (2000). Making Sense of Word Problems. Educational Studies in Mathematics, 42(2), 211–213. https://doi.org/10.1023/A:1004190927303
Solikha, M., & Nurtamam, M. E. (2021). Perbaikan Pembelajaran Untuk Meningkatkan Kemampuan Menyelesaikan Soal Cerita Menggunakan Strategi Number Head Together (Nht). OSF Preprints, 1(2), 38–47.

Journal of Ecohumanism
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https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.5471

Strohmaier, A. R., Reinhold, F., Hofer, S., Berkowitz, M., Vogel-Heuser, B., & Reiss, K. (2022). Different complex word problems require different combinations of cognitive skills. Educational Studies in Mathematics, 109(1), 89–114. https://doi.org/10.1007/s10649-021-10079-4

Tavakolizadeh, J., & Ebrahimi-Qavam, S. (2011). Effect of teaching of self-regulated learning strategies on self-efficacy in students. Procedia - Social and Behavioral Sciences, 29, 1096–1104. https://doi.org/10.1016/j.sbspro.2011.11.343

Tee, K. N., Leong, K. E., & Abdul Rahim, S. S. (2021). A Self-Regulation Model of Mathematics Achievement for Eleventh-Grade Students. International Journal of Science and Mathematics Education, 19(3), 619–637. https://doi.org/10.1007/s10763-020-10076-8

Verschaffel, L., Depaepe, F., & Van Dooren, W. (2015). Individual differences in word problem solving. In R. C. Kadosh & A. Dowker (Eds.), The Oxford handbook of numerical cognition (pp. 953–974). Oxford University Press.

Verschaffel, L., Schukajlow, S., Star, J., & Van Dooren, W. (2020). Word problems in mathematics education: A survey. ZDM - Mathematics Education, 52(1), 1–16. https://doi.org/10.1007/s11858-020-01130-4

Yuanita, P., Zulnaidi, H., & Zakaria, E. (2018). The effectiveness of Realistic Mathematics Education approach: The role of mathematical representation as mediator between mathematical belief and problem solving. PLoS ONE, 13(9), 1–20. https://doi.org/10.1371/journal.pone.0204847

Zimmerman, B. J., & Moylan, A. R. (2009). Self-regulation: Where metacognition and motivation intersect. In Handbook of metacognition in education. (pp. 299–315). Routledge/Taylor & Francis Group.

Zimmerman, B. J., & Schunk, D. H. (2001). Self-Regulated Learning and Academic Achievement: Theoretical Perspectives. Routledge.