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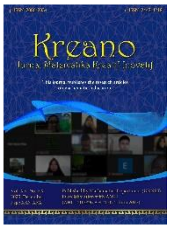

# Word-Problem Solving Instruction and Motivation: Influences on Mathematics Performance, Self-Efficacy, and Self-Regulated Learning in Secondary Students

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**Abstract**

Although word problem-solving is widely recognized as central to mathematics education, existing intervention studies predominantly focus on cognitive outcomes, with limited empirical examination of non-cognitive variables such as self-regulated learning, self-efficacy, and the moderating role of students' motivational orientation within experimental designs. This study investigates the influence of a word problem-solving (WPS) intervention on secondary school students' mathematics performance, SRL, and self-efficacy, while examining the interaction effect of intrinsic and extrinsic motivation. A quasi-experimental pretest–posttest control group design was employed, involving 128 eighth-grade students from a private secondary school in Indonesia who were assigned to either a WPS class or a conventional problem-solving class. Mathematics performance was measured using an essay-based problem-solving test, while motivation, SRL, and self-efficacy were assessed through self-report questionnaires. Instrument validity was established through expert judgment and item–total correlation analysis, and reliability was confirmed using Cronbach's alpha coefficients. Data were analyzed using multivariate analysis of covariance (MANCOVA), controlling for pretest scores, and effect sizes were calculated to determine the magnitude of the effects. The results indicate significant improvements across all dependent variables, with the WPS intervention demonstrating larger effect sizes ($0.106 < \eta^2 < 0.650$) than motivation alone ($0.059 < \eta^2 < 0.243$). Intrinsically motivated students benefited more from the intervention, exhibiting greater gains in self-regulation, self-efficacy, and mathematics performance than their extrinsically motivated peers. A significant interaction between instructional approach and motivation suggests that students' motivational orientation influences intervention effectiveness. Despite its limitations, this study highlights the importance of integrating cognitive and non-cognitive factors, particularly self-efficacy and self-regulated learning, into mathematics instruction. Future research should employ randomized controlled trials with larger and more diverse samples, as well as longer intervention durations, to strengthen causal inference and generalizability.

**Keywords**: Mathematics; Self-Efficacy; Self-Regulated Learning; Word-Problem Solving

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**_Abstrak_**

*Meskipun pemecahan masalah berbasis soal cerita (word problem-solving) secara luas diakui sebagai komponen sentral dalam pendidikan matematika, sebagian besar penelitian intervensi yang ada masih berfokus pada luaran kognitif, dengan keterbatasan kajian empiris terhadap variabel non-kognitif seperti self-regulated learning (SRL), efikasi diri, serta peran moderasi orientasi motivasi siswa dalam desain eksperimental. Penelitian ini bertujuan untuk mengkaji pengaruh intervensi pemecahan masalah berbasis soal cerita (Word Problem-Solving/WPS) terhadap performansi matematika, SRL, dan efikasi diri siswa sekolah menengah, sekaligus menelaah efek interaksi antara motivasi intrinsik dan ekstrinsik. Penelitian ini menggunakan desain kuasi-eksperimental pretest–posttest control group yang melibatkan 128 siswa kelas VIII dari sebuah sekolah menengah swasta di Indonesia, yang dibagi ke dalam kelas WPS dan kelas pemecahan masalah konvensional. Performansi matematika diukur menggunakan tes pemecahan masalah berbentuk soal uraian, sedangkan motivasi, SRL, dan efikasi diri diukur menggunakan kuesioner laporan diri. Validitas instrumen ditetapkan melalui penilaian ahli dan analisis korelasi item–total, sementara reliabilitas dikonfirmasi menggunakan koefisien Cronbach's alpha. Data dianalisis menggunakan Multivariate Analysis of Covariance (MANCOVA) dengan mengontrol skor pretest, serta perhitungan ukuran efek untuk menentukan besarnya pengaruh. Hasil penelitian menunjukkan peningkatan yang signifikan pada seluruh variabel dependen, dengan intervensi WPS menunjukkan ukuran efek yang lebih besar ($0{,}106 < \eta^2 < 0{,}650$) dibandingkan pengaruh motivasi semata ($0{,}059 < \eta^2 < 0{,}243$). Siswa dengan motivasi intrinsik memperoleh manfaat yang lebih besar dari intervensi, yang ditunjukkan melalui peningkatan SRL, efikasi diri, dan performansi matematika yang lebih tinggi dibandingkan siswa dengan motivasi ekstrinsik. Interaksi yang signifikan antara pendekatan pembelajaran dan motivasi menunjukkan bahwa orientasi motivasi siswa memengaruhi efektivitas intervensi. Meskipun memiliki keterbatasan, penelitian ini menegaskan pentingnya integrasi faktor kognitif dan non-kognitif, khususnya efikasi diri dan self-regulated learning, dalam pembelajaran matematika. Penelitian selanjutnya disarankan menggunakan uji coba terkontrol secara acak dengan sampel yang lebih besar dan beragam, serta durasi intervensi yang lebih panjang, untuk memperkuat inferensi kausal dan generalisasi temuan.*

## INTRODUCTION

A key goal of mathematics education is to develop students' problem-solving abilities so they can apply mathematical concepts in real-life contexts (Liljedahl & Cai, 2021; NCTM, 2000). Word problem-solving is a central component of the mathematics curriculum, as it enables students to connect abstract mathematical ideas with everyday situations, making mathematics both practical and meaningful (Strohmaier et al., 2022). Accordingly, educators and curriculum designers are encouraged to prioritize problem-solving as a core focus of mathematics instruction . (NCTM, 2000).

Word problem-solving skills are critical beyond schooling, serving as predictors of employment prospects, earning potential, and readiness for higher education and future careers ( (Hein & Smerdon, 2013; Powell et al., 2022; Verschaffel et al., 2020). However, despite their recognized importance, many students—particularly at the elementary and middle school levels—continue to experience substantial difficulties in solving word problems (L. S. Fuchs et al., 2021; Pongsakdi et al., 2020). Given that word problems connect mathematics to real-life contexts and predict success in higher-order mathematical thinking, strengthening problem-solving instruction is especially important for countries such as Indonesia that seek to enhance human capital and global competitiveness through improved mathematics education (Verschaffel et al., 2020).

At the national level, this challenge is reflected in Indonesia's performance in the 2023 Programme for International Student Assessment (PISA), where students scored 379 in mathematics and 371 in reading, ranking 68th globally. PISA word problems require students to integrate reading comprehension, information interpretation, and mathematical reasoning—processes that many students find cognitively demanding (OECD, 2018). Empirical studies in Indonesia further indicate that students often struggle to understand problem statements and translate them into mathematical representations (Riyadi et al., 2021), as well as to evaluate and interpret their solutions, a difficulty frequently associated with didactic and teacher-centered instructional practices (Amaliya et al., 2024; Sari et al., 2021). In the context of the present study, these findings indicate that improving word problem-solving cannot rely solely on procedural instruction, but requires instructional designs that explicitly support students' cognitive engagement with problem contexts.

These patterns are not unique to Indonesia but reflect a broader challenge in mathematics education worldwide (Verschaffel et al., 2020; Vicente et al., 2020)The so-called *"word-problem problem"* " Khoshaim (2020), highlights that students' failures in word problem solving are commonly rooted not in computational deficiencies, but in limitations in text comprehension and meaning-making processes required to interpret problem contexts accurately (Amaliya et al., 2024; Strohmaier et al., 2022). From our perspective, this highlights the need to view word problem-solving as a cognitively and linguistically demanding activity, rather than a purely procedural task.

Consistent with this view, prior research shows that students often find it easier to execute algorithmic procedures than to grasp underlying mathematical concepts, a tendency that may discourage teachers from engaging learners with more cognitively demanding (Akhter et al., 2015; Csíkos & Szitányi, 2020). Nevertheless, word problems remain essential for cultivating transferable skills applicable to real-life contexts and mathematics-intensive disciplines such as the physical sciences and accounting. As emphasized by Csíkos and Szitányi (2020), word problem-solving has long served as a cornerstone of mathematics education precisely because it connects mathematical reasoning with meaningful real-world applications.

Despite their instructional importance, many students experience persistent difficulties in interpreting and solving word problems. These difficulties include challenges in visualizing problem situations (Moleko, 2021), understanding problem statements and translating them into mathematical equations (Amaliya et al., 2024; Powell & Fuchs, 2018), and overreliance on keywords that often leads to incorrect solution strategies (Hardy et al., 2025).Solving word problems requires the integration of reading comprehension, information processing, and mathematical (L. Fuchs et al., 2020); however, classroom instruction frequently emphasizes mechanical procedures rather than fostering these higher-order cognitive processes (Mukuka et al., 2023). This mismatch highlights the need for instructional strategies that prioritize conceptual understanding and meaningful problem interpretation.

A substantial body of observational studies have examined word-problem-solving-related issues. Fuchs et al. (2021) posited that word problem solving can be seen as a form of text comprehension, highlighting the need for instructional approaches that integrate language skills. Similarly, Pongsakdi et al. (2020) found that performance in word problem-solving is closely linked to both text comprehension and arithmetic skills. Students with strong arithmetic skills but weaker text comprehension performed better on simpler problems, whereas both skills were essential for addressing more complex problems.

Despite this extensive observational evidence, intervention studies capable of establishing causal relationships remain limited. Existing interventions have predominantly focused on cognitive outcomes such as mathematics achievement and problem-solving performance (Anwar et al., 2019; Da, 2023; Novitasari & Shodikin, 2020; Pongsakdi et al., 2019; Solikha & Nurtamam, 2021), while the effects on non-cognitive factors—such as students' beliefs, self-efficacy, and self-regulated learning—are still insufficiently understood. Although Finland's Word Problem Enhancement Program (WPE) demonstrated significant gains in non-routine and application-based problem solving (Pongsakdi et al., 2019), it remains unclear whether such interventions systematically influence non-cognitive processes or how students' motivational orientation moderates instructional effectiveness. Given the central role of agency, self-efficacy, and motivation in learning (Bandura, 2001; Güner & Erbay, 2021; Özcan & Eren Gümüş, 2019; Schukajlow et al., 2018), further experimental research integrating cognitive and non-cognitive dimensions is warranted.

Accordingly, this study aims to explore the effectiveness of a word problem-solving intervention, the role of motivation, and their interaction effects on mathematics performance, self-regulated learning (SRL), and self-efficacy. Furthermore, we examine whether the intervention's effectiveness is moderated by students' dominant motivational orientation, specifically, whether they are intrinsically or extrinsically motivated, given the theoretical expectation that such dispositions influence how students respond to pedagogical innovations.

Based on these considerations, we formulated the following hypotheses (see Figure 1):

H1: Intervention or class has a significant influence on combined mathematics performance, SRL, and self-efficacy scores.

H1a: The Word problem-solving intervention strategy leads to better mathematics problem-solving skills than those of the control group.

H1b: The Word Problem-Solving intervention strategy will result in higher self-efficacy levels than in the control group.

H1c: The Word Problem-Solving intervention strategy enhances SRL levels more than those in the control group.

H2: Motivation significantly affects combined mathematics performance, SRL, and self-efficacy levels.

H2a: Students with a tendency toward intrinsic motivation, regardless of the group assignment (intervention or control), will perform better in mathematics problem-solving skills.

H2b: Students with a tendency toward intrinsic motivation, regardless of group assignment, will exhibit higher self-efficacy.

H2c: Students with a tendency toward intrinsic motivation, regardless of group assignment, demonstrate higher SRL levels.

H3: There is a significant interaction's effect, which means that the intervention's effect on combined outcomes of mathematics performance, SRL, and self-efficacy differs depending on the type of motivation.

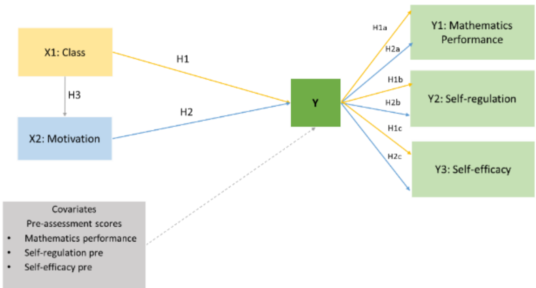


*Figure 1.* Hypotheses Formulation

## METHOD

This study employed a quasi-experimental pretest–posttest control group design to examine the effects of a word problem-solving (WPS) intervention on students' mathematics performance, self-regulated learning (SRL), and self-efficacy, as well as the moderating role of motivation. To minimize instructional bias, both the intervention and control groups were taught by the same teacher using the same curriculum content—systems of linear equations with two variables—over five weeks, with three 45-minute lessons per week. The independent variables were type of instruction (WPS vs. conventional problem-solving/CPS) and type of motivation (intrinsic vs. extrinsic), while the dependent variables were mathematics problem-solving performance, SRL, and self-efficacy. Motivation was measured prior to the intervention, whereas SRL, self-efficacy, and mathematics performance were assessed both before and after the intervention. Baseline equivalence between the WPS and CPS groups was examined using independent-samples *t*-tests on pretest scores for mathematics performance, self-regulated learning, and self-efficacy. Figure 2 illustrates the research flow and the methodology used in this study.

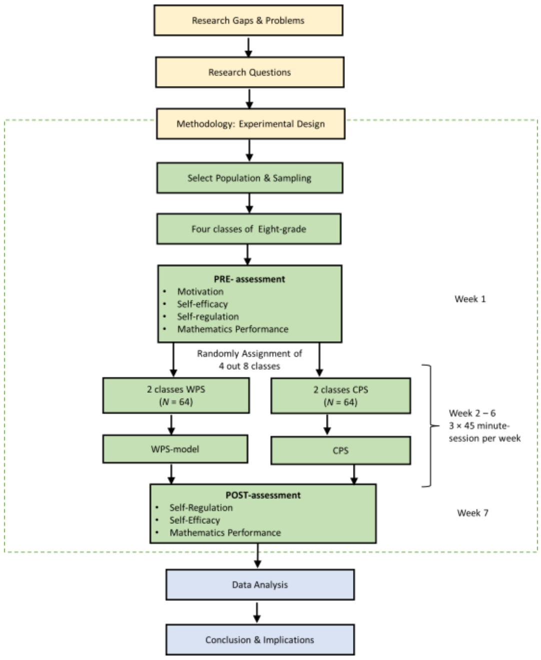


*Figure 2.* Research Flow and Methodology

Participants were 128 eighth-grade students (aged 13–15) from a private junior high school in Surabaya, Indonesia. A priori power analysis using G*Power 3.1.9.7 for a repeated-measures MANOVA within–between interaction design (effect size = 0.30, α = 0.05, power = 0.85, two groups, two measurement points) indicated a minimum sample size of 119 (Erdfelder et al., 2009).Four classes were randomly selected from eight available classes and subsequently assigned to either the WPS group or the CPS group, resulting in 64 students per group.

The instructional content followed the national Grade 8 mathematics curriculum and covered five subtopics: (1) systems of linear equations with two variables, (2) elimination method, (3) substitution method, (4) mixed elimination–substitution method, and (5) applications of systems of linear equations. Table 1 provides the detailed structure for each session, including the sequence of activities for both instructional approaches.

Table 1. Overview of Activities of WPS and CPS Classes

| | Word Problem-Solving | Conventional Problem-Solving |
|---|---|---|
| Structure | 1. Introduction to Learning<br>2. Presenting the Problem<br>3. Understanding the Problem<br>4. Developing a Solution Plan/ Strategy<br>5. Implementing the Solution<br>6. Concluding the Results<br>7. Evaluating the Answer<br>8. Reflection<br>9. Providing Practice | 1. Introduction to Learning**<br>2. Problem Identification.<br>3. Understanding the Problem<br>4. Planning the Solution<br>5. Implementing the Solution<br>6. Evaluating the Solution<br>7. Reflection<br>8. Transfer |
| Similarities | | |
| Introduction to Learning<br>Understanding the Problem | Introduce the concept<br>Prioritize understanding the problem by analyzing important elements and simplifying the problem into more manageable parts. | |
| Planning and Executing Solutions | Plan and execute strategies or steps to solve problems, using relevant calculation techniques. | |
| Reflection | Emphasize the importance of reflecting on the problem-solving process, with discussions on the strategies used, challenges faced, and ways to improve. | |
| Differences | | |
| Focus | Understanding the context of problems presented in word form and structured reflection. | Systematic problem definition and analysis. |
| Strategies | Various approaches such as pattern recognition, using diagrams, or tables. | Selecting the appropriate methods or algorithms. |
| Evaluation of Results | Interpreting results in the context of the problem. | Assessing the effectiveness of the solutions used. |
| Additional Practice vs. Knowledge Transfer | Additional practice with gradually increasing difficulty. | Transferring knowledge to other contexts or situations. |

Both groups received identical content, instructional duration, and assessment schedules. The WPS group was taught using a structured word problem-solving approach emphasizing problem understanding, strategy development, solution execution, and reflection, whereas the CPS group followed conventional problem-solving instruction commonly used in prior years. Pretests were administered before the intervention and posttests after the completion of the instructional period. Ethical approval was obtained from the Institutional Review Board of Universitas Negeri Surabaya.

Students' motivation was measured using a questionnaire adapted from (Lestari & Yudhanegara, 2015), which is widely used in Indonesian mathematics education research and based on the Motivated Strategies for Learning Questionnaire (Duncan & McKeachie, 2005). The instrument comprised 40 items assessing intrinsic and extrinsic motivation on a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree). Negative items were reverse-coded. Students were categorized as intrinsically or extrinsically motivated based on which subscale yielded a higher total score.

Self-efficacy was assessed using a 12-item questionnaire adapted from Bandura's (1997) framework and previously validated in Indonesian educational contexts ((Jamaluddin et al., 2023; Setyarini, 2019). Responses were recorded on a 4-point Likert scale ranging from strongly disagree to very appropriate.

Self-Regulated Learning was measured using a 30-item questionnaire developed by (Lestari & Yudhanegara, 2015), according to Zimmerman's perspective on SRL (Zimmerman & Moylan, 2009). Items assessed students' planning, monitoring, and reflection processes on a 4-point frequency scale (1 = never to 4 = always). Negative items were reverse-scored prior to analysis.

Mathematics problem-solving performance was measured using a researcher-developed test consisting of four essay questions on systems of linear equations. Each item was scored on a scale of 1–5, yielding a maximum total score of 20. The test was designed in accordance with Polya's four stages of problem-solving (Polya, 1973).

Validity and reliability testing was conducted prior to the main study using a pilot sample of 31 students who did not participate in either the intervention or control groups. This preliminary assessment was intended to ensure that all instruments accurately and consistently measured the intended constructs. Content validity for the motivation, self-regulated learning (SRL), and self-efficacy questionnaires was established through expert judgment by specialists in mathematics education, who evaluated item relevance, clarity, and representativeness. Based on their feedback, minor revisions were made to improve construct alignment.

Construct validity of the questionnaire items was examined using Pearson's product–moment correlation by comparing item–total correlation coefficients with the critical value at a significance level of $\alpha = 0.05$ ($df = n - 2$). Items were considered valid if the absolute correlation coefficient exceeded 0.355. Internal consistency reliability was assessed using Cronbach's alpha coefficients. All questionnaires demonstrated satisfactory reliability, with alpha values exceeding 0.70 for motivation, SRL, and self-efficacy, indicating good internal consistency (Field, 2017). A summary of item validity and reliability results is presented in Table 2.

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Table 2. Pearson Correlation Coefficient (*r*) and Cronbach Alpha of All Questionnaires

| Scale | Correlation Coefficient (r) | Number of Items | | Cronbach Alpha |
|---|---|---|---|---|
| | | Original | Final | |
| Motivation | - 0.060 to 0.459 | 40 | 34 | 0.852 |
| Self-regulated learning | - 0.049 to 0.547 | 30 | 24 | 0.807 |
| Self-efficacy | 0.421 to 0.643 | 12 | 12 | 0.788 |

Table 3. Pearson Correlation Coefficient (r) of Instrument for Problem-Solving Test

| Number | Correlation ($r$) | Cronbach Alpha |
|---|---|---|
| Problem 1 | 0.823 | 0.750 |
| Problem 2 | 0.699 | |
| Problem 3 | 0.819 | |
| Problem 4 | 0.706 | |

After ensuring that the instruments were valid and reliable, data were collected. Motivation scores were computed by summing intrinsic and extrinsic subscale scores, while self-regulated learning (SRL) and self-efficacy scores were calculated by summing item responses. The study hypotheses were tested using a two-way multivariate analysis of covariance (MANCOVA) to examine the effects of instructional type (WPS vs. CPS) and motivation (intrinsic vs. extrinsic) on posttest outcomes. Pretest scores of mathematics performance, SRL, and self-efficacy were included as covariates to control for baseline differences between groups. Effect sizes were calculated to assess the magnitude of observed effects (Field, 2017). All analyses were conducted using SPSS 25.0 and R, with a significance level of 0.05.

## RESULT AND DISCUSSION

### Results

The results indicate that students who received the word problem-solving (WPS) intervention demonstrated greater improvements in mathematics performance, self-regulated learning (SRL), and self-efficacy compared to those who received conventional problem-solving (CPS) instruction. Descriptive analyses further suggest that these gains were more pronounced among intrinsically motivated students across instructional conditions. Baseline comparisons confirmed that the intervention and control groups were equivalent prior to instruction, allowing subsequent changes to be attributed to the instructional intervention.

*Descriptive Statistics*

Table 4 presents descriptive statistics for mathematics performance, self-regulated learning (SRL), and self-efficacy before and after the intervention. Both CPS and WPS classes showed improvements across all outcomes. However, the magnitude of change was consistently larger in the WPS class. For mathematics performance, the WPS group increased by $\Delta = 3.55$ points (from $M = 11.36$ to $M = 14.91$), compared to $\Delta = 1.97$ points in the CPS group. Similar patterns were observed for SRL, with the WPS class showing a mean increase of $\Delta = 5.82$ (from $M = 65.41$ to $M = 71.23$), exceeding the CPS gain of $\Delta = 3.97$. For self-efficacy, students in the WPS class demonstrated a larger improvement ($\Delta = 3.92$) than those in the CPS class ($\Delta = 2.75$). Across all variables, intrinsically motivated students exhibited greater mean gains than extrinsically motivated students within both instructional conditions, indicating a descriptively stronger intervention effect for students with intrinsic motivation.

Independent *t*-tests confirmed no significant initial differences between groups in mathematics performance ($t(126) = -1.757$, $p = 0.081$), self-regulated learning ($t(126) = -1.739$, $p = 0.085$), or self-efficacy ($t(126) = -1.793$, $p = 0.075$). This equivalence at baseline ensures that subsequent improvements can be confidently attributed to the intervention itself rather than natural progression.

Table 4. Descriptive Statistics of All Dependent Variables

| Variables | Class | Motivation | N | Pre | | Post | |
|---|---|---|---|---|---|---|---|
| | | | | Mean | SD | Mean | SD |
| SRL | CPS | intrinsic | 26 | 63.58 | 4.356 | 68.23 | 4.642 |
| | | extrinsic | 38 | 63.53 | 6.341 | 67.03 | 6.712 |
| | | Total | 64 | 63.55 | 5.58 | 67.52 | 5.947 |
| | WPS | intrinsic | 27 | 67.74 | 6.346 | 74.63 | 7.223 |
| | | extrinsic | 37 | 63.70 | 6.119 | 68.76 | 6.326 |
| | | Total | 64 | 65.41 | 6.49 | 71.23 | 7.276 |
| self-efficacy | CPS | intrinsic | 26 | 31.81 | 2.466 | 35.00 | 3.370 |
| | | extrinsic | 38 | 31.74 | 2.901 | 34.18 | 3.311 |
| | | Total | 64 | 31.77 | 0.34 | 34.52 | 3.333 |
| | WPS | intrinsic | 27 | 33.15 | 2.051 | 38.41 | 2.735 |
| | | extrinsic | 37 | 32.32 | 3.520 | 35.27 | 3.949 |
| | | Total | 64 | 32.67 | 0.38 | 36.59 | 3.799 |
| mathematics performance | CPS | intrinsic | 26 | 11.19 | 2.098 | 13.04 | 1.969 |
| | | extrinsic | 38 | 10.55 | 1.622 | 12.61 | 1.569 |
| | | Total | 64 | 10.81 | 0.23 | 12.78 | 1.741 |
| | WPS | intrinsic | 27 | 11.85 | 1.460 | 15.89 | 1.476 |
| | | extrinsic | 37 | 11.00 | 1.748 | 14.19 | 1.630 |
| | | Total | 64 | 11.36 | 0.21 | 14.91 | 1.770 |

*Multivariate Analysis of Covariance (MANCOVA)*

After verifying all assumptions, MANCOVA was performed to assess the effects of class (intervention) and motivation (intrinsic vs. extrinsic) on mathematics performance, self-regulated learning, and self-efficacy, controlling for their pre-test scores. As shown in Table 5, Multivariate results indicated significant effects of the intervention, motivation, and their interaction on combined outcomes. Additionally, all covariates were highly significant predictors, accounting substantially for variance in post-assessment scores.

Beyond the contribution of prior ability, the multivariate results revealed a strong overall effect of instructional type. The main effect of class was significant (Pillai's Trace = 0.650, $F(3, 119) = 73.614$, $p < 0.001$), with a large effect size ($\eta^2 = 0.650$), indicating that the word problem-solving intervention produced substantial improvements across the combined outcomes of mathematics performance, self-regulated learning, and self-efficacy compared to conventional instruction, thus supporting H1. Motivation also demonstrated a significant multivariate effect (Pillai's Trace = 0.243, $F(3, 119) = 12.743$, $p < 0.001$, $\eta^2 = 0.243$), suggesting that students with intrinsic motivation

Table 5. Multivariate Tests of MANCOVA

| Variable | Pillai's Trace | F (3, 119) | p-value | $\eta^2$ |
|---|---|---|---|---|
| Mathematics Performance Pre | 0.862 | 247.639 | 0.000 | 0.862 |
| Self-Regulated Learning Pre | 0.833 | 198.139 | 0.000 | 0.833 |
| Self-Efficacy Pre | 0.844 | 214.946 | 0.000 | 0.844 |
| Class | 0.650 | 73.614 | 0.000 | 0.650 |
| Motivation | 0.243 | 12.743 | 0.000 | 0.243 |
| Class * Motivation | 0.167 | 7.959 | 0.000 | 0.167 |

consistently achieved higher posttest outcomes than those with extrinsic motivation, regardless of instructional condition, in line with H2.

Table 5 also shows a significant interaction effect between instructional type and motivation (Pillai's Trace = 0.167, $F(3, 119) = 7.959$, $p < 0.001$, $\eta^2 = 0.167$). This interaction indicates that the effectiveness of the word problem-solving intervention varied according to students' motivational orientation, with intrinsically motivated students benefiting more strongly from the intervention than extrinsically motivated students. This finding confirms H3 and emphasizes the role of motivation as a moderating factor in the relationship between instructional strategy and learning outcomes.

Moreover, Table 6 presents the univariate (between-subjects) effects from the MANCOVA analysis, allowing a more detailed examination of how each independent variable and covariate uniquely contributed to post-test outcomes. After controlling for pretest scores, instructional type (class) emerged as the strongest predictor across all dependent variables, particularly for mathematics performance ($p < 0.001$, $\eta^2 = 0.637$), indicating a large practical impact of the WPS intervention. Moderate effects of class were also observed for self-efficacy ($p < 0.001$, $\eta^2 = 0.146$) and self-regulated learning ($p < 0.001$, $\eta^2 = 0.106$), suggesting that the intervention influenced both cognitive and non-cognitive outcomes, albeit to different extents.

Motivation type showed significant but comparatively smaller effects, with the largest influence observed on self-efficacy ($p < 0.001$, $\eta^2 = 0.210$), followed by self-regulated learning ($p = 0.004$, $\eta^2 = 0.066$) and mathematics performance ($p = 0.002$, $\eta^2 = 0.076$). This pattern indicates that motivational orientation played a more prominent role in shaping students' beliefs and learning regulation than their performance outcomes. In addition, the pretest covariates for each dependent variable were highly significant and accounted for substantial variance in post-test scores, underscoring the importance of controlling for baseline differences when evaluating intervention effects.

Table 6. Univariate (Between-Subjects Effect) Tests of MANCOVA

| Variables | Dependent Variables | $F$ (1, 121) | $p$ | $\eta^2$ |
|---|---|---|---|---|
| self-regulated learning pre | Mathematics performance | 4.515 | 0.036 | 0.036 |
| | self-regulated learning | 549.360 | 0.000 | 0.820 |
| | Self-efficacy | 5.732 | 0.018 | 0.045 |
| self-efficacy pre | Mathematics performance | 0.005 | 0.942 | 0.000 |
| | self-regulated learning | 0.712 | 0.401 | 0.006 |
| | Self-efficacy | 566.051 | 0.000 | 0.824 |
| mathematics performance pre | Mathematics performance | 743.119 | 0.000 | 0.860 |
| | self-regulated learning | 2.311 | 0.131 | 0.019 |
| | Self-efficacy | 0.012 | 0.913 | 0.000 |
| Class | Mathematics performance | 212.300 | 0.000 | 0.637 |
| | self-regulated learning | 14.303 | 0.000 | 0.106 |
| | Self-efficacy | 20.607 | 0.000 | 0.146 |
| Motivation | Mathematics performance | 9.897 | 0.002 | 0.076 |
| | self-regulated learning | 8.481 | 0.004 | 0.066 |
| | Self-efficacy | 32.141 | 0.000 | 0.210 |
| Class * Motivation | Mathematics performance | 19.192 | 0.000 | 0.137 |
| | self-regulated learning | 0.593 | 0.443 | 0.005 |
| | Self-efficacy | 7.519 | 0.007 | 0.059 |

Regarding interaction effects, the class × motivation term significantly predicted mathematics performance ($p < 0.001$, $\eta^2 = 0.137$) and self-efficacy ($p = 0.007$, $\eta^2 = 0.059$), but not self-regulated learning ($p = 0.443$, $\eta^2 = 0.005$). This finding suggests that while motivation moderated the impact of the WPS intervention on performance and confidence-related outcomes, improvements in self-regulated learning were primarily driven by the instructional approach itself rather than by students' motivational orientation.

Figure 3 presents the estimated marginal means of mathematics performance, SRL, and self-efficacy at post-assessment across instructional type and motivation. Across all outcomes, the highest mean scores were consistently observed among intrinsically motivated students in the WPS class, while the lowest means occurred among extrinsically motivated students in the CPS class. For mathematics performance and self-efficacy, the plotted lines indicate a clear interaction pattern in which the gap between intrinsic and extrinsic motivation widens under the WPS condition, supported by significant interaction effects (mathematics performance: $p < 0.001$, $\eta^2 = 0.137$; self-efficacy: $p = 0.007$, $\eta^2 = 0.059$). In contrast, although SRL scores increased from CPS to WPS for both motivational groups, the roughly parallel lines indicate that the interaction between class and motivation was not significant for SRL ($p = 0.43$), suggesting that the WPS intervention improved SRL similarly for intrinsically and extrinsically motivated students.

Overall, the intervention (class) showed a consistently larger effect than motivation across outcomes. Among all outcomes, the strongest effect was observed for mathematics performance under the WPS intervention, indicating that instructional design played a more decisive role than motivational orientation alone.

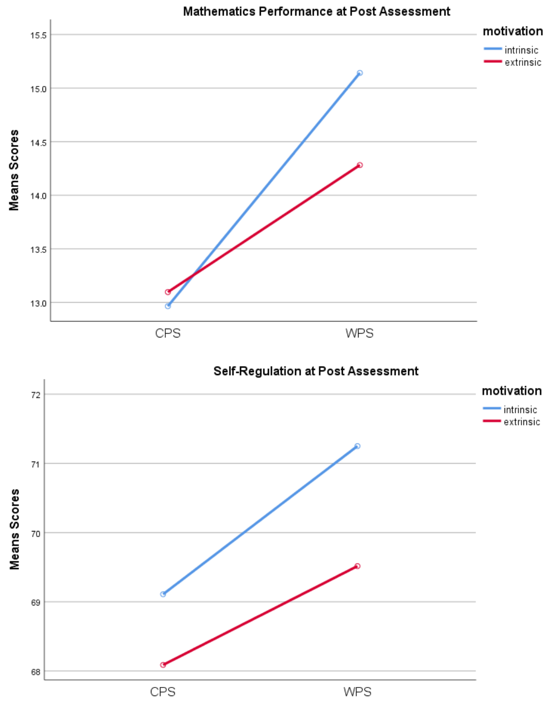


*Figure 3*. Interaction Plot for Mathematics Performance, SRL, and Self-Efficacy. Estimated Marginal Means of Mathematics, SRL, and Self-Efficacy at Post-Assessment by Class and Motivation Type

## Discussion

Word problems in mathematics present significant challenges for secondary students, especially in developing countries like Indonesia, which ranks low in PISA mathematics scores. While instructional strategies for solving word problems have improved mathematical performance, their impact on non-cognitive factors, notably students' motivation, remains unclear. This study evaluates a specifically designed word problem-solving (WPS) intervention's influence on mathematics performance, self-regulated learning, and self-efficacy compared to conventional problem-solving (CPS) methods, also exploring interactions between instruction type and motivation.

A MANCOVA test showed significant main effects of intervention type and motivation on all outcomes, indicating these factors collectively and individually influenced students' performance, self-regulation, and self-efficacy. The concurrent improvements across these variables align with previous research (OECD, 2010; Pongsakdi et al., 2019), emphasizing comprehensive benefits in learning strategies. This study uniquely evaluates self-regulation and self-efficacy as outcomes rather than predictors, highlighting the WPS intervention's role in fostering essential learning strategies that enhance mathematical achievement.

Furthermore, the greater improvements among intrinsically motivated students align with Self-Determination Theory (SDT), which suggests intrinsic motivation, driven by internal rewards and personal interest, leads to higher engagement and better performance (Ryan & Deci, 2017). The word problem-solving (WPS) approach likely enhanced students' sense of autonomy by encouraging active engagement with meaningful problem contexts, strengthened perceived competence through successful problem resolution, and supported relatedness via collaborative classroom interactions. This theoretical lens provides a robust explanation for why intrinsically motivated students benefited more strongly from the intervention, as SDT posits that learning environments aligned with these needs are more effective in sustaining engagement and deep learning than those driven primarily by external regulation. These findings corroborate previous research highlighting the critical role of motivational factors in educational interventions (Adamma et al., 2018; Özcan & Eren Gümüş, 2019; Pongsakdi et al., 2019). For example, Pongsakdi et al. (2019) reported differential effects of the Word Problem Enhancement program depending on students' initial motivational profiles, with improvements in beliefs and problem-solving performance varying accordingly. In line with these results, intrinsically motivated students in the current study showed consistently greater improvements than extrinsically motivated peers, particularly within the WPS condition, underscoring motivation as a key mechanism influencing mathematics learning outcomes.

Interestingly, despite our intervention focusing solely on instructional strategies for teaching word problem-solving, without explicitly targeting self-regulation or self-efficacy, we observed significant improvements in both SRL and self-efficacy. This finding extends prior research (Abín et al., 2020; García et al., 2016; Özcan & Eren Gümüş, 2019), which typically examined these factors as predictors rather than outcomes. SRL characterized by managing thoughts, actions, and environments to achieve learning goals, involves core processes such as goal-setting, planning, and reflection. The observed improvements indicate students proactively applied various learning strategies during problem-solving activities, aligning with Zimmerman's model (Zimmerman & Schunk, 2001), which emphasizes the cyclical and agentic nature of self-regulation. However, our study did not specify which SRL strategies were employed, nor did it distinguish clearly between behavioral and motivational regulation (Tee et al., 2021). Given that behavioral regulation strongly predicts academic achievement and motivational regulation significantly influences mathematical reasoning, future studies should explicitly investigate these distinctions

Moreover, the intervention significantly improved self-efficacy which supports better mathematics outcomes. Research shows that students with high self-efficacy sustain effort, persist through challenges, and use effective learning strategies, while those with low self-efficacy are more prone to maladaptive behaviors and anxiety (Hoffman, 2010; Pajares, 2008; Pajares & Miller, 1995). Our finding aligns with prior research (Martinek & Kipman, 2016), showing how instructional strategies can promote self-efficacy and SRL. Although our intervention did not explicitly target non-cognitive factors, the problem-solving approach likely fostered SRL and confidence through deeper engagement with mathematical tasks.

While both intervention and motivation independently affect SRL, self-efficacy, and mathematics performance, the significant interaction effect of these factors indicates that the intervention's effectiveness varies based on students' motivational levels. Specifically, the intervention's impact on these outcomes was more pronounced among students with higher intrinsic motivation. These students are likely to benefit more from the WPS strategy because their internal drive to learn and succeed enhances the positive effects of the intervention. Conversely, students with extrinsic motivation also showed improvements, but to a lesser extent, suggesting that external rewards and pressures might not be as effective in maximizing the benefits of the intervention.

## Implication

From a practical perspective, the findings suggest that word problem-solving instruction should be implemented alongside strategies that deliberately accommodate students' motivational differences. For intrinsically motivated students, open-ended problems, opportunities for strategy exploration, and reflective discussion can further enhance engagement and learning outcomes. In contrast, for students with lower intrinsic motivation, word problem-solving instruction should be accompanied by autonomy-supportive scaffolding, such as guided questioning, structured prompts, timely feedback, and a gradual release of responsibility, to support engagement and facilitate the internalization of learning goals. Aligning instructional practices with students' motivational profiles may therefore maximize the effectiveness of word problem-solving interventions in heterogeneous classrooms.

Building on these insights, our study reinforces the value of incorporating non-cognitive factors, such as self-efficacy and SRL, into the evaluation and design of educational programs. Educators and policymakers should consider integrating structured word problem-solving interventions into secondary school curricula while deliberately fostering intrinsic motivation. Given that pre-intervention measures of SRL and self-efficacy accounted for a substantial proportion of the variance in post-intervention outcomes, these competencies should be cultivated prior to or alongside mathematics instruction. Previous research has shown that confidence in one's mathematical abilities and belief in overcoming learning challenges are closely associated with improved mathematical performance (OECD, 2010; Rafiola et al., 2020; Trautner & Schwinger, 2020). By adopting a multidimensional instructional approach that integrates cognitive strategies with efforts to build learning agency, through SRL, self-efficacy, and intrinsic motivation (Code, 2020), educators can create a more empowering and effective learning environment.

## Limitation

Although this study demonstrated positive effects of the word problem-solving (WPS) intervention on mathematics performance, self-regulated learning (SRL), and self-efficacy, several limitations should be acknowledged, along with their methodological implications for future research. First, the quasi-experimental design limits the strength of causal inferences; therefore, future studies should employ randomized controlled trials to enhance internal validity and better control for potential confounding variables. Second, while the sample size was sufficient for the applied analyses, all participants were drawn from a single secondary school, which may restrict the generalizability of the findings to other instructional contexts. This limitation highlights the need for multi-site and longitudinal research designs to strengthen external validity and to examine the stability of motivational effects across diverse educational settings.

Moreover, the intervention was implemented over a relatively short duration and focused on a single mathematical topic, namely systems of linear equations, which may have captured short-term instructional effects rather than sustained learning gains. Future research should therefore consider longer implementation periods across multiple mathematical domains to assess the durability and transferability of the observed effects. In addition, the present study did not distinguish between behavioral and motivational dimensions of SRL, suggesting that future investigations should employ more fine-grained SRL instruments or mixed-method approaches to capture these processes more precisely. Finally, as motivation was treated as a dispositional factor, subsequent experimental designs could incorporate autonomy-supportive or motivational scaffolding interventions to more rigorously examine causal mechanisms underlying motivation, self-regulation, and mathematics performance. Advanced analytical approaches, such as structural equation modeling, are also recommended to further explore the complex interrelationships among self-efficacy, SRL, and learning outcomes (Fadlelmula et al., 2015; Özcan & Eren Gümüş, 2019).

## CONCLUSION

In summary, this study contributes to mathematics education research by demonstrating that the effectiveness of word problem-solving instruction is not uniform across learners, but is meaningfully shaped by students' motivational orientation. From a theoretical perspective, the findings extend prior word problem-solving research by empirically integrating cognitive outcomes (mathematics performance) with non-cognitive processes (self-regulated learning and self-efficacy), and by positioning motivation as a moderating mechanism rather than a peripheral factor.

From a practical standpoint, the results suggest that word problem-solving instruction is most effective when implemented alongside learning environments that support intrinsic motivation, autonomy, and self-regulation. While extrinsically motivated students also benefit from structured problem-solving instruction, their comparatively smaller gains indicate the need for additional pedagogical supports to foster engagement and internalized motivation. Accordingly, mathematics teachers are encouraged to design problem-solving activities that not only emphasize procedural accuracy, but also promote meaningful engagement, reflection, and motivational support. Despite its limitations, this study highlights the importance of aligning instructional strategies with students' motivational characteristics and provides a foundation for future experimental and longitudinal research aimed at developing motivation-sensitive mathematics instruction.

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