

Analysis of Critical Thinking Skills and Self-Efficacy in Mathematical Problem Solving among Grade VII Students on Linear Equations in One Variable at Sriwarin School Thailand

Novayana Gajah^{1*}, Masdelima Azizah Sormin¹, Nur Sahara¹, Johan Pador²

Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Tapanuli Selatan, Padangsidempuan, Indonesia¹

Sriwarin School, Narathiwat, Thailand²

E-mail Corresponding: novayanagajah7@gmail.com

Received: May 30, 2026

Revised: July 23, 2026

Accepted: September 17, 2026

Abstract

This study aims to describe the critical thinking skills, self-efficacy, and mathematical problem-solving ability of Grade VII-1 students at Sriwarin School, Thailand, in solving linear equations in one variable. This study employed a descriptive quantitative approach involving 30 students selected through purposive sampling. The research instruments consisted of critical thinking and mathematical problem-solving tests, a Likert-scale self-efficacy questionnaire, interviews, and observation sheets. The results showed that the three variables had the same descriptive distribution: 8 students (26.7%) were categorized as high, 14 students (46.7%) as moderate, and 8 students (26.7%) as low. The class average scores were 54.8 for critical thinking skills, 42.7 for self-efficacy, and 63.2 for mathematical problem-solving ability, all of which were categorized as moderate. These findings indicate that the students' critical thinking skills, self-efficacy, and mathematical problem-solving ability generally showed moderate profiles, with similar category distributions across the three variables. The study provides a descriptive overview of students' critical thinking, self-efficacy, and mathematical problem-solving profiles in learning linear equations in one variable.

Keywords: Critical Thinking Skills; Descriptive Qualitative; Mathematical Problem-Solving Ability; PLSV; Self-Efficacy; Sriwarin School

INTRODUCTION

Mathematics plays an important role in everyday life and serves as a foundation for the development of science and technology. Mathematical problem-solving ability is therefore regarded as an essential competency for students in the 21st century, as it requires them not only to apply mathematical procedures but also to interpret information, analyze problems, develop appropriate strategies, and evaluate solutions. However, international assessments continue to indicate challenges in students' mathematical performance in Southeast Asia. The 2022 PISA results show that the mathematics performance of students in Thailand remained below the OECD average, highlighting the continuing need to strengthen students' mathematical competencies and problem-solving abilities (OECD, [2023](#)). This concern becomes particularly relevant at the lower secondary level, where students begin to encounter more abstract mathematical concepts, including linear equations in one variable. In a multicultural school context such as Sriwarin School in Thailand, examining students' mathematical problem-solving profiles is important because differences in students' learning backgrounds may be reflected in how they approach mathematical problems. However, the specific profiles of Grade VII students' mathematical problem-solving ability in learning linear equations in one variable, particularly in relation to their critical thinking skills and self-efficacy, remain insufficiently described. This gap provides a basis for examining these three aspects among Grade VII students at Sriwarin School.

Mathematics learning in schools often falls short of expectations, largely because most students view mathematics negatively, as a frightening specter that makes them reluctant to study mathematics (Yuwono et al., [2020](#)). Meanwhile, mathematics learning plays an important role in shaping students' thinking and logical reasoning in solving everyday problems. To face the problems that arise in life, students need to possess problem-solving ability (Rahmawati et al., [2021](#)).

Critical thinking in mathematics involves the ability to understand and clarify information, identify relationships among mathematical concepts, draw logical conclusions, evaluate the validity of strategies and solutions, and reflect on one's own reasoning process. These abilities can be examined through five indicators: interpretation, analysis, inference, evaluation, and self-regulation (Aziz et al., [2023](#)). In mathematical problem solving, interpretation enables students to understand the information and requirements of a problem, while analysis helps them identify relevant relationships and strategies. Inference involves drawing appropriate conclusions from the available information, evaluation concerns assessing the accuracy and appropriateness of the reasoning or solution, and self-regulation involves monitoring and reflecting on one's own thinking process. Students with stronger critical thinking skills are therefore expected to be better equipped to analyze mathematical information and construct appropriate solutions to complex problems (Kusuma et al., [2026](#)). Mathematics learning that provides opportunities for students to explore, justify their reasoning, and evaluate different solution strategies can support the development of these critical thinking skills (Prajono et al., [2022](#)).

In addition to cognitive factors such as critical thinking, psychological factors also play an equally important role in students' success in solving mathematical problems (Dea Damianti & Ekastya, [2022](#)). One psychological factor that influences students' learning success is *self-efficacy*. *Self-efficacy* is an individual's belief in their ability to complete a task or achieve a particular goal. The concept of *self-efficacy* was first introduced by Bandura and remains one of the important variables in educational research, particularly in mathematics learning (Azizatul, [2023](#)).

The dimensions of *self-efficacy* comprise three main aspects, namely: (1) *Magnitude/Level*, which refers to the level of students' confidence in their ability to solve mathematical problems ranging from the easiest to the most difficult; (2) *Strength*, which relates to the firmness of students' confidence when facing difficulties; and (3) *Generality*, which indicates the extent to which students' confidence can be applied across different mathematical situations and contexts (Agustina & Munandar, [2022](#)). These dimensions are closely related to students' mathematical problem-solving processes and critical thinking. Students with a higher *magnitude/level* of self-efficacy are more likely to perceive challenging problems as manageable, enabling them to formulate appropriate solution plans and select relevant strategies. *Strength* supports students' persistence when encountering difficulties, encouraging them to continue analyzing problems, reconsider unsuccessful strategies, and seek alternative solutions rather than giving up. Meanwhile, *generality* enables students to apply their confidence and problem-solving strategies across different mathematical situations, which can support the transfer of reasoning and critical thinking skills. Furthermore, students with strong self-efficacy are more likely to engage in reflective behaviors, such as evaluating the validity of their strategies and checking the accuracy and reasonableness of their solutions. Thus, *magnitude/level*, *strength*, and *generality* are not only dimensions of students' confidence in their mathematical abilities but also factors that can shape their planning, persistence, and checking behaviors during mathematical problem solving.

Sriwarin School is a junior secondary school located in southern Thailand and serves students from diverse cultural, linguistic, and social backgrounds. This multicultural context provides an important setting for examining students' mathematical learning because differences in students' backgrounds may shape how they engage with mathematical tasks, particularly tasks that require reasoning, evaluation, and the application of multiple strategies.

At the junior secondary level, students are expected to move beyond procedural computation toward higher-order mathematical thinking and more complex problem solving. However, based on the researchers' preliminary observations at Sriwarin School, many students still experience difficulties when solving mathematical problems that require higher-order thinking (Sormin et al., 2023). This condition is academically important because difficulties in higher-order problem solving may not only be associated with students' cognitive abilities but may also be related to their confidence in performing mathematical tasks. Therefore, investigating students' critical thinking and *self-efficacy* in this multicultural junior secondary context can provide a more comprehensive understanding of the factors underlying their mathematical problem-solving ability. Nevertheless, studies examining the relationship among critical thinking, *self-efficacy*, and mathematical problem-solving ability within a multicultural junior secondary school context in southern Thailand remain limited. This contextual and research gap provides a strong rationale for profiling students' critical thinking and *self-efficacy* and examining their relationship with mathematical problem-solving ability at Sriwarin School.

Based on the above description, the objectives of this study are: (1) to describe the critical thinking ability of Grade VII-1 junior secondary students at Sriwarin School in solving mathematical problems; (2) to describe the *self-efficacy* of Grade VII-1 junior secondary students toward mathematics; and (3) to analyze the patterns and tendencies of students' mathematical problem-solving ability in relation to their levels of critical thinking ability and *self-efficacy*. The results of this study are expected to provide theoretical and practical contributions to a better understanding of students' critical thinking, *self-efficacy*, and mathematical problem-solving ability, as well as to support the development of more effective mathematics learning in a multicultural and international school setting.

METHODS

This study employed a descriptive qualitative approach supported by quantitative descriptive analysis. The qualitative component was used to obtain an in-depth understanding of students' critical thinking, *self-efficacy*, and mathematical problem-solving processes through interviews and classroom observations, whereas the quantitative descriptive component was used to summarize students' test and questionnaire results through scores, percentages, and categorical distributions. This design was considered appropriate because the study not only sought to describe the levels of students' critical thinking, *self-efficacy*, and mathematical problem-solving ability but also to examine in greater depth how these characteristics were manifested in students' problem-solving processes. The quantitative results were used to identify general patterns across the class, while the qualitative data from the six focal subjects were used to explain and enrich these patterns. In accordance with Creswell and Creswell (2023), the integration of quantitative descriptive findings with qualitative evidence enables a phenomenon to be described both in terms of its general distribution and its contextual characteristics.

The study was conducted at Sriwarin School, Narathiwat Province, Thailand, during the even semester of the 2025/2026 academic year and focused on Grade VII-1 students. The class consisted of 30 students, all of whom participated in the quantitative data collection; therefore, the sampling technique for the class was total sampling rather than *purposive sampling*. The 30 students completed the critical thinking and mathematical problem-solving tests and the *self-efficacy* questionnaire. Subsequently, six students were selected purposively as focal subjects for in-depth qualitative investigation. The six focal subjects were selected to represent variations in students' mathematical performance and levels of critical thinking and *self-efficacy*, thereby allowing the researchers to examine differences in students' reasoning, strategies, confidence, and difficulties during problem solving. The selection of one intact Grade VII-1 class was also considered relevant because it provided a common instructional and sociocultural context for all participants while reflecting the multicultural characteristics of the school.

Data collection was conducted sequentially over four weeks. First, the researchers obtained permission from the school and conducted preliminary classroom observations to understand the learning context and students' participation in mathematics lessons. Second, all 30 students completed the *self-efficacy* questionnaire and the critical thinking and mathematical problem-solving essay tests under the same testing conditions. Each test consisted of five essay items, with a maximum score of 20 for each item and a total maximum score of 100. The questionnaire was administered before the problem-solving test to identify students' initial levels of mathematical *self-efficacy*; a post-test administration was conducted to observe whether students' responses showed any change after engaging in the problem-solving task. Third, based on the results of the tests and questionnaire, six focal subjects representing different levels and patterns of performance were selected for in-depth interviews. The interviews explored students' reasoning processes, strategies, confidence, difficulties, and considerations when solving the mathematical problems. Fourth, the researchers conducted member checking by presenting the interpretation of the focal subjects' responses to the students to ensure that the researchers' interpretation accurately represented their intended meaning. Finally, the data from tests and questionnaires were integrated with interview and observation findings. Quantitative results provided the distribution and category patterns, whereas interview and observation data were used to explain the reasons and characteristics underlying those patterns, thereby enabling methodological triangulation across data sources.

The research instruments consisted of critical thinking and mathematical problem-solving essay tests, a *self-efficacy* questionnaire, interview protocols, and an observation guide. The essay tests comprised five problems developed to represent the indicators of critical thinking and mathematical problem solving addressed in this study. Each response was assessed using an analytical scoring rubric with a maximum score of 20 per item, producing a maximum total score of 100; the rubric considered the accuracy, completeness, and quality of students' responses according to the relevant indicators. The instruments were reviewed for content validity by experts in mathematics education, and the scoring procedure was established to ensure consistency in evaluating students' written responses. The *self-efficacy* questionnaire consisted of 15 items covering three dimensions: *magnitude/level*, *strength*, and *generality*, with five items representing each dimension. Responses were recorded on a four-point Likert scale, producing total scores ranging from 15 to 60. Students' *self-efficacy* was classified as high (46–60), moderate (31–45), or low (15–30). The questionnaire items were reviewed and adapted to the mathematical learning context and were subjected to expert validation before administration. The interview and observation instruments were developed in accordance with the research objectives and the indicators examined in the tests and questionnaire. All participants were informed about the purpose and procedures of the study, participation was voluntary, student assent and parental consent were obtained where required, and permission was obtained from the school. Students' identities were kept confidential by using codes rather than names in the data and reporting. Because the study was conducted in a Thai school context, the instruments and interview questions were administered in a language that was understandable to the students, with appropriate language adaptation to ensure that differences in language comprehension did not interfere with their responses.

Table 1. Data Source Triangulation in the Study

Aspect Analyzed	Data Source	Data Collection Method	Instrument
Critical thinking ability <i>Self-Efficacy</i>	Students' written answers	Critical thinking test	PLSV essay questions
	Verbalization of thinking process	Interview	Observation sheet
	Self-perception	Likert scale	Self-Efficacy questionnaire
	Verbal expression of self-confidence		
Problem-solving ability	Written solution steps	Problem-solving test	PLSV essay questions
	Explanation of strategy	Interview	

RESULT AND DISCUSSION

Results

The mathematics critical thinking test consisted of five essay questions on linear equations in one variable (PLSV), developed based on five indicators: interpretation, analysis, inference, evaluation, and self-regulation. Separately, the mathematical problem-solving ability test also consisted of five PLSV essay questions (Series, 2019). Both tests were administered to all 30 Grade VII-1 students at Sriwarin School in two separate sessions. Each question in each test had a maximum score of 20 points, resulting in a maximum total score of 100 for each test. For data interpretation, students' scores were classified into three categories—high, moderate, and low—using predetermined score intervals for each instrument. For the critical thinking test, the scores were classified as low (0–49), moderate (50–67), and high (68–84), whereas the mathematical problem-solving ability scores were classified as low (0–54), moderate (55–74), and high (75–100). These intervals were used as predetermined classification criteria to facilitate the interpretation of students' performance levels rather than being derived from the empirical distribution of the 30 students. Based on these criteria, the critical thinking test results are presented in Table 2, while the mathematical problem-solving ability test results are presented in Table 3.

Table 2. Distribution of Students' Critical Thinking Test Results

Category	Score	Number of Students	Percentage	Average Score
High	68 – 84	8 siswa	26,7%	72,5
Moderate	50 – 67	14 siswa	46,7%	58,6
Low	0 – 49	8 siswa	26,7%	31,4
Total / Class Average	-	30 siswa	100%	54,8

Based on Table 2, the overall average critical thinking score for grade VII-1 was 54.8, which falls into the moderate category. As many as 8 students (26.7%) reached the high category with an average score of 72.5, showing good mastery of all critical thinking indicators (interpretation, analysis, inference, evaluation, and self-regulation). The majority of students, 14 students (46.7%), fell into the moderate category with an average score of 58.6, meaning they were able to perform interpretation and analysis but still experienced difficulty at the inference and self-regulation stages. Meanwhile, 8 students (26.7%) fell into the low category with an average score of 31.4, showing significant obstacles across nearly all critical thinking indicators.

The mathematical problem-solving ability test consisted of 5 PLSV essay questions developed based on four stages: understanding the problem, planning a solution, carrying out the plan, and checking back. Each question had a maximum score of 20 points, so the maximum total score was 100. The categorization of problem-solving ability was based on three score ranges set according to the assessment standard.

Table 3. Distribution of Students' Problem-Solving Ability Test Results

Category	Score	Number of Students	Percentage	Average Score
High	75 – 100	8 siswa	26,7%	82,5
Moderate	55 – 74	14 siswa	46,7%	65,4
Low	0 – 54	8 siswa	26,7%	41,8
Total / Class Average	-	30 siswa	100%	63,2

Based on Table 3, the overall average mathematical problem-solving score for grade VII-1 was 63.2, which falls into the moderate category. As many as 8 students (26.7%) reached the high category with an average score of 82.5, showing good mastery of all four problem-solving stages. The majority of students, 14 students (46.7%), fell into the moderate category with an average score of 65.4, meaning they were able to get through the problem-understanding and solution-planning stages but experienced difficulty at the implementation and re-checking

stages. Meanwhile, 8 students (26.7%) fell into the low category with an average score of 41.8, showing significant obstacles starting from the problem-understanding stage. Overall, the problem-solving test results were higher than the critical thinking results, with an average difference of 8.4 points.

The self-efficacy questionnaire consisted of 15 statement items covering three dimensions: *magnitude/level* (5 items), *strength* (5 items), and *generality* (5 items). Each item was measured using a four-point Likert scale: 1 = Strongly Disagree (STS), 2 = Disagree (TS), 3 = Agree (S), and 4 = Strongly Agree (SS), resulting in a possible total score ranging from 15 to 60. Prior to administration, the questionnaire was reviewed by experts in mathematics education to establish content validity, particularly with respect to the relevance, clarity, and suitability of the items for measuring students' mathematical *self-efficacy*. The internal consistency of the questionnaire was examined using Cronbach's alpha, which yielded a coefficient of **0.87**, indicating good internal consistency. These validity and reliability procedures provided a basis for using the questionnaire to describe students' mathematical *self-efficacy*. For descriptive interpretation, the total scores were classified into three predetermined categories based on the theoretical score range: low (15–30), moderate (31–45), and high (46–60). The results of the self-efficacy questionnaire analysis for the 30 students are presented in Table 4.

Table 4. Distribution of Students' Mathematics Self-Efficacy Questionnaire Results

Category	Score	Number of Students	Percentage	Average Score
High	46-60	8 siswa	26,7%	56,3
Moderate	31-45	14 siswa	46,7%	43,2
Low	15-30	8 siswa	26,7%	28,6
Total / Class Average	-	30 siswa	100%	42,7

Based on Table 4, the average mathematics *self-efficacy* score of Grade VII-1 students was 42.7, which falls within the moderate category. The distribution shows that 8 students (26.7%) had high *self-efficacy*, 14 students (46.7%) had moderate *self-efficacy*, and 8 students (26.7%) had low *self-efficacy*. Descriptively, this distribution shows a parallel pattern with the distribution of students' mathematical problem-solving ability presented in Table 3, in which the moderate category also represented the largest proportion of students (46.7%), followed by the high and low categories (26.7% each). This parallel pattern suggests that students with moderate levels of *self-efficacy* constituted the largest group alongside students with moderate problem-solving ability. However, this descriptive pattern should not be interpreted as evidence of a statistical correlation between *self-efficacy* and mathematical problem-solving ability, as no correlation analysis was conducted. The finding instead provides a descriptive basis for further examination of how students' levels of *self-efficacy* are manifested in their mathematical problem-solving processes.

Discussion

The qualitative analysis was conducted on six *focal subjects* selected from the 30 Grade VII-1 students who participated in the initial quantitative data collection. The selection was carried out purposively after the students' critical thinking test, mathematical problem-solving test, and *self-efficacy* questionnaire had been scored and categorized. Two students were selected from each performance category—high, moderate, and low—to ensure that the qualitative analysis represented variation in students' characteristics rather than focusing on a single level of performance. Within each category, the focal subjects were selected based on the completeness of their written responses, their ability to demonstrate the relevant critical thinking indicators, and their willingness and ability to explain their reasoning during the interview. Thus, the six focal subjects consisted of two high-category students, two moderate-category students, and two low-category students. This selection procedure enabled cross-case comparison of students' critical thinking processes across different performance levels while

reducing the potential for selection based solely on individual researcher preference. The critical thinking profiles of the six focal subjects were subsequently analyzed using five indicators adapted from Amalia et al. (2022), namely interpretation, analysis, inference, evaluation, and self-regulation.

High-ability group (S1 and S2, test scores 85 and 80): Both students showed strong mastery of all critical thinking indicators. On question 2 (a contextual problem on determining the price of goods using a linear equation in one variable), S1 was able to identify relevant and irrelevant data in the problem, then formulate and solve the equation systematically. In the interview, S1 explained: 'First I read the question slowly, I looked for what was given and what was asked. Then I set up a variable before writing the equation.' The ability to sort information and model the situation into an equation reflects a good interpretation and analysis component. S2 consistently rechecked his/her answers by substituting the variable value back into the original equation, and on question 4 succeeded in finding an error in an algebraic step, which was immediately corrected before submitting the answer sheet.

Moderate-ability group (S3 and S4, test scores 68 and 62): S3 showed good interpretation ability but experienced obstacles in the inference component. On question 3 about a linear equation in one variable in a word-problem context, S3 was able to identify what was known and asked, but had difficulty setting up a variable and formulating the correct equation. S3 stated: 'I know what I'm looking for is the value, but I don't know how to turn it into an equation.' This statement indicates a gap between conceptual understanding of PLSV and the ability to model it procedurally. S4 tended to work hard and try several different approaches, but rarely performed a final check by substitution, so some answers that were actually correct were left unverified.

Low-ability group (S5 and S6, test scores 45 and 38): Both students experienced significant obstacles from the first stage of problem solving onward. On question 1, which was relatively easy (determining the value of a variable in a simple linear equation of the form $ax + b = c$), S5 immediately performed the calculation without writing down what was known, what was asked, or the solution steps in a systematic order. When asked why, S5 answered: 'I just calculated it directly so I could finish quickly.' This strategy reflects a lack of careful planning and minimal self-regulation ability in the problem-solving process. S6 had difficulty understanding the meaning of the variable in a PLSV-based word problem and needed a very long time just to identify what was known from the problem, so many questions were left unfinished within the given time limit.

Table 5. Critical Thinking Profiles of the Six Focal Subjects by Indicator

Critical Thinking Indicator	S1 (High)	S2 (High)	S3 (Moderate)	S4 (Moderate)	S5 (Low)	S6 (Low)
Interpretation and Problem Clarification	Very Good	Very Good	Good	Good	Poor	Poor
Analysis of Arguments and Information	Very Good	Very Good	Good	Fair	Poor	Poor
Inference and Conclusion Drawing	Very Good	Good	Fair	Fair	Poor	Very Poor
Evaluation and Solution Explanation	Very Good	Very Good	Good	Fair	Poor	Poor
Self-Regulation	Very Good	Good	Fair	Poor	Poor	Very Poor
Average Test Score	85	80	68	62	45	38

Note: S1–S6 = codes assigned to the six focal subjects; High, Moderate, and Low refer to the students' critical thinking performance categories. The indicator ratings are interpreted as Very Good, Good, Fair, Poor, and Very Poor.

Analysis of the *self-efficacy* questionnaire and interview data revealed significant differences in mathematical self-confidence among the student groups. The results of the 15-item questionnaire were combined with interview data to obtain a comprehensive picture of the *self-efficacy* of each focal subject.

In the high-ability group, S1 obtained a questionnaire score of 58 (out of a maximum of 60) and S2 obtained a score of 55. During the interview, S1 stated: 'I believe I can solve even difficult math problems, because I always practice and don't give up easily.' This statement reflects strong *self-efficacy* across all three dimensions: *magnitude* (believing one can work on difficult problems), *strength* (not giving up easily), and *generality* (applying across various problem contexts). S2 showed a similar pattern, actively seeking alternative strategies when hitting a dead end, which is a strong indicator of the *strength* dimension.

In the moderate-ability group, S3 obtained a questionnaire score of 45 and S4 obtained a score of 41. They showed situational *self-efficacy* — high in familiar problem contexts but dropping sharply on PLSV problems. S4 stated: 'If the problem is similar to the practice questions in the book, I'm confident I can do it. But if the format is different or there's a long word problem, I lose confidence.' This statement indicates a limited *generality* dimension: self-confidence has not yet been transferred to new problem contexts.

In the low-ability group, S5 obtained a questionnaire score of 30 and S6 obtained a score of only 27. Both consistently expressed doubt about their mathematical ability. S6 stated: 'Math is really hard for me. Every time I try to work on a problem, I already feel unsure beforehand.' A high level of *mathematics anxiety* reinforced their low *self-efficacy*, creating a psychological barrier that prevented them from optimizing the ability they actually possess (Mulyono & Hapizah, 2021; Supriyati and Kurniasih 2021).

Table 6. *Self-Efficacy Scores and Number of Correctly Answered Questions of the Focal Subjects*

Subject	Category	Questionnaire Score (max. 60)	Dominant Dimension	Test Score (max. 100)	Correct Answers (out of 5)
S1	High	58	Magnitude & Strength	85	5
S2	High	55	Strength & Generality	80	4
S3	Moderate	45	Magnitude	68	3
S4	Moderate	41	Magnitude	62	3
S5	Low	30	–	45	1
S6	Low	27	–	38	1

Based on the overall analysis of data from 30 grade VII-1 students, strengthened by in-depth interviews with 6 *focal subjects*, three clear patterns of relationship were found between critical thinking ability, *self-efficacy*, and mathematical problem-solving ability.

The first pattern, termed Positive Synergy (High Group), was observed among the high-performing focal cases. The two high-category students demonstrated strong performance across the five critical thinking indicators and relatively high *self-efficacy*, accompanied by strong mathematical problem-solving performance. On average, students in the high group correctly solved 4.2 of the five problems. The written responses indicated that these students were generally able to interpret the given information, analyze relevant arguments, draw appropriate inferences, evaluate their solutions, and regulate their problem-solving process. Interview data further showed that they were willing to persist when encountering challenging items and were confident in reviewing or revising their solutions. This pattern can be interpreted through Bandura's concept of *self-efficacy*, in which stronger beliefs in one's capability are associated with greater effort, persistence, and willingness to engage with difficult tasks. In this context, critical thinking provides the cognitive resources needed to analyze and evaluate mathematical problems, while *self-efficacy* appears to support students' persistence in applying those resources during problem solving. This interpretation is consistent with Hidayat and Noer (2021), who reported that *self-efficacy* is an important factor associated with students' success in mathematical problem solving. Thus, the high-group cases illustrate how cognitive competence and confidence may operate in a complementary manner during mathematical problem solving, although the present qualitative findings do not establish a causal relationship between the two variables.

The second pattern, termed Fluctuating Interaction (Moderate Group), was identified among students in the moderate category. The fourteen students in this group showed greater variation in problem-solving performance across the five problems, with an average of 3.1 correctly solved problems. The qualitative cases indicated that moderate critical thinking ability did not always correspond to equally stable problem-solving performance. In some cases, students demonstrated adequate analytical processes in their written work but experienced uncertainty when explaining or continuing their solutions during the interview. This pattern suggests that having a certain level of cognitive ability may not always be accompanied by consistent confidence when students encounter unfamiliar or difficult mathematical tasks. From a theoretical perspective, *self-efficacy* is related to students' willingness to initiate, sustain, and regulate their efforts when facing challenging tasks; therefore, fluctuations in confidence may be reflected in the consistency with which students apply their existing mathematical reasoning. This interpretation is in line with Supriyati and Kurniasih (2021), who emphasized the importance of students' *self-efficacy* in mathematics learning, and with Sormin et al. (2023), who highlighted the relevance of students' cognitive and affective characteristics in mathematical problem solving. Accordingly, the moderate-group pattern is better understood as an interaction between developing critical thinking skills and varying levels of confidence rather than as evidence that *self-efficacy* directly determines problem-solving performance.

The third pattern, termed Negative Cycle (Low Group), was observed in the low-category focal cases and was characterized by the co-occurrence of weak critical thinking performance, low *self-efficacy*, and limited mathematical problem-solving performance. The eight students in the low group correctly solved an average of 1.3 of the five problems. The written responses of the low-category focal subjects showed difficulties in interpreting the problem, identifying relevant information, drawing appropriate inferences, evaluating solutions, and regulating their problem-solving process. These findings were complemented by the interviews with S5 and S6, in which the students expressed uncertainty and mathematics-related anxiety when dealing with difficult problems and showed a tendency to hesitate before continuing their solutions. The combination of these test and interview findings provides evidence for a recurring pattern in which difficulties in critical thinking were accompanied by low confidence and reluctance to persist with challenging tasks. However, the available data do not establish that low *self-efficacy* caused weak critical thinking or that the two variables mutually reinforced each other over time. Therefore, the term *Negative Cycle* is used to describe the observed pattern of co-occurring difficulties rather than to imply a demonstrated causal cycle. This interpretation is broadly consistent with Agustina et al. (2022) and Dea Damianti and Ekastya (2022), who reported that low *self-efficacy* can be associated with greater difficulties in students' mathematical problem-solving processes. The present findings extend this perspective by showing how low confidence and difficulties in critical thinking appeared together in the observed focal cases.

Overall, the six focal cases demonstrated a descriptive alignment between students' critical thinking performance, *self-efficacy*, and mathematical problem-solving ability. The high-category cases showed relatively strong performance across these aspects, the moderate cases displayed greater variation in the consistency of their performance, and the low-category cases showed the simultaneous presence of weaker critical thinking, lower *self-efficacy*, and more substantial problem-solving difficulties. These patterns are consistent with the descriptive distributions presented for the full group of 30 students, in which the moderate category represented the largest proportion for both critical thinking and mathematical problem-solving ability. However, the qualitative findings should be interpreted primarily as evidence from the six focal cases rather than as proof that the same relationship pattern applies uniformly to all 30 students. In particular, the absence of a case with a clear mismatch between critical thinking and *self-efficacy* among the six focal subjects suggests a pattern of alignment within the selected cases, but it cannot be generalized to the entire sample without a complete cross-tabulation of

the two variables for all 30 students. Thus, the findings support the view that critical thinking and *self-efficacy* are important complementary dimensions in understanding students' mathematical problem-solving performance, while further quantitative analysis would be required to determine the strength and statistical significance of their relationship (Tussakynah et al., [2024](#)).

CONCLUSION AND RECOMMENDATIONS

Conclusion

Based on the findings and discussion involving 30 Grade VII-1 students at Sriwarin School, Thailand, three main conclusions can be drawn. First, students' overall mathematical critical thinking ability was in the moderate category, with a class average of 54.8. The distribution consisted of 26.7% of students in the high category, 46.7% in the moderate category, and 26.7% in the low category. Among the five critical thinking indicators, inference and self-regulation emerged as the most challenging aspects, particularly among students in the moderate and low categories. Second, students' mathematics *self-efficacy* was also in the moderate category, with an average score of 42.7 out of a maximum of 60. The distribution consisted of 26.7% of students with high *self-efficacy*, 46.7% with moderate *self-efficacy*, and 26.7% with low *self-efficacy*. This distribution showed a parallel descriptive pattern with students' mathematical problem-solving ability, although the finding does not establish a statistical correlation between the variables. Third, the six focal cases demonstrated three descriptive patterns in the co-occurrence of critical thinking, *self-efficacy*, and mathematical problem-solving ability: positive synergy among the high-category cases, fluctuating interaction among the moderate-category cases, and a negative pattern of co-occurring difficulties among the low-category cases. These findings indicate that critical thinking and *self-efficacy* are important complementary aspects to consider when understanding students' mathematical problem-solving performance, while further quantitative analysis is needed to determine the strength and significance of their relationship.

Recommendations

Based on these findings, several specific and actionable recommendations are proposed. First, mathematics teachers at Sriwarin School should provide explicit and repeated practice in inference, particularly through problem-solving tasks that require students to identify relevant information, formulate conclusions from given evidence, and justify why a particular solution is reasonable. Teachers can use *open-ended problem solving* and follow-up questions such as "What can you conclude from this information?" and "Why is your conclusion reasonable?" to strengthen students' inferential reasoning. Second, self-regulation should be developed through structured problem-solving routines in which students are required to plan a solution, monitor their progress, check the validity of their answers, and reflect on the strategies they have used. A simple checklist or reflection sheet can be incorporated after each problem-solving activity to make these processes explicit. Third, for students in the low critical-thinking and low-*self-efficacy* group, teachers should provide gradual and structured support rather than immediately assigning highly difficult problems. Instruction can begin with manageable problems, provide guided prompts and examples, and gradually increase task difficulty as students demonstrate successful performance. Specific positive feedback should emphasize students' strategies, effort, and progress rather than merely the correctness of their answers, thereby providing opportunities for successful experiences and strengthening mathematical *self-efficacy*. Individual or small-group guidance can also be provided to students who continue to experience difficulties with inference and self-regulation. Finally, future researchers are encouraged to involve larger and more diverse samples from different grade levels and schools and to employ correlational or mixed-methods designs to quantitatively examine the relationship among critical thinking, *self-efficacy*, and mathematical problem-solving ability.

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