

IBL-CRIG, SELF-EFFICACY, AND MATHEMATICAL PROBLEM SOLVING IN ISLAMIC HIGHER EDUCATION

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ABSTRACT

This study aims to examine the effect of the Inquiry-Based Learning (IBL) model, specifically the CRIG framework, on the Mathematical Problem-Solving Ability (MPSA) of mathematics education students at an Islamic higher education institution in Bandung, with consideration for their self-efficacy (SE) levels. Employing a quasi-experimental design with 56 students, the sample was divided into an IBL-CRIG framework group and a Direct Instruction (DI) group. Data were collected using valid and reliable instruments for MPSA and SE, and subsequently analyzed through two-way ANOVA and descriptive statistics. The results indicate that the IBL-CRIG framework model is more effective in enhancing overall MPSA, yielding an average score of 39.54 compared to 31.43 for the DI model. Significant differences in MPSA achievement were observed based on both the instructional model and SE levels (low, medium, and high); however, no significant interaction was found between the instructional model and SE levels. Regarding SE, students in both groups fell within the medium-to-high range, with the IBL-CRIG group showing strengths in mental effort and support indicators, while the DI group excelled in focus and reward indicators. The integration of problem-solving methods with Islamic spiritual values fosters contextual solutions that are technically effective, ethical, and sustainable. Consequently, the IBL-CRIG framework serves as an effective primary instructional approach for optimally enhancing students' mathematical problem-solving abilities across all levels of self-efficacy.

Keywords: IBL-CRIG Framework, Islamic Values, Mathematical Problem-Solving, Real Analysis, Self-Efficacy

INTRODUCTION

Mathematical problems can be viewed as unusual challenges that cannot be solved immediately; they are typically non-routine problems that one may not have encountered before. Similarly, the challenges one faces in daily life are often new and cannot always be resolved right away. The adage “think before you act” holds, as careful thought leads to the right course of action. By integrating mathematical problem-solving as an exercise in logical reasoning with the challenges of real life as a means for personal maturation and underpinning this process with self-efficacy, one establishes a solid foundation for developing students into resilient, honest, and responsible individuals, grounded in maximum effort, patience, and resilience (Voica & Singer, 2012; Klang et al., 2021; Wakjira et al., 2026). The processes of *tafakkur* (contemplation) and *tasyakkur* (gratitude) form a positive cycle in the development of knowledge a process that is not merely cognitive (IQ) in nature, but also serves as a means for cultivating emotional intelligence (EQ) and spiritual intelligence (SQ), which are inherently, synergistically, and mutually reinforcing in relation to one's overall intelligence (Rahmasari & Aminullah, 2025). This cycle begins with thinking activities that give birth to knowledge and method development, to producing knowledge that originates from empirical experience, critical thinking, and is supported by rationality and divine revelation (Firdaus, 2021).

In the context of mathematics education, problem-solving, particularly involving non-routine problems designed to foster advanced-level understanding, serves as the creative and engaging heart of mathematics (Grieser, 2018). At an advanced level, one form of problem-solving manifests as mathematical proof; these two concepts are closely intertwined and mutually complementary within the process of mathematical thinking (Selden and Selden, 2013). Consequently, proficiency in problem-solving and mathematical proof has become a vital competency for prospective mathematics teachers (Maryono et al., 2023). Likewise, problem-solving is a key element in identifying non-instantaneous solutions (Schoenfeld, 1985) while simultaneously fostering critical, logical, and systematic thinking, all of which are essential learning outcomes (Schunk, 2012; Pendis, 2018; Sydoruk, 2018; Agustina and Nuriyatin, 2023). However, in advanced mathematics courses such as Real Analysis and Complex Analysis, students often encounter fundamental challenges, including errors in connecting concepts, limited reasoning capabilities, and a tendency toward purely procedural thinking (Sucipto and Mauliddin, 2016; Abdullah et al., 2024; Anggraini et al., 2025).

Research findings confirm that difficulties in constructing initial proofs, a lack of open-minded thinking, and psychological barriers are the primary factors hindering optimal performance in analysis courses (Sugilar, 2017; Fitriani & Siahaan, 2022; Hanifah, 2022; Sugilar, Nuraida & Habeeb, 2022). In the affective domain, students often struggle to grasp course material or derive meaning from concepts and theorems. These difficulties frequently stem from issues with conceptual understanding, beginning with formal definitions as well as a lack of reference materials or, potentially, a lack of student diligence (Darmadi, 2015). Contributing factors include the abstract nature of the subject matter and poor study habits (Septiati, E. (2021)). The process of discovering proofs requires creativity, mastery of problem-solving strategies, and an understanding of various proof techniques, all of which are developed gradually through mathematical exploration (Grieser, 2018). Thus, the ability to overcome obstacles and impasses is a crucial factor in building strong self-efficacy.

In Albert Bandura's Social Cognitive Theory, overcoming obstacles and dead ends is very important for developing strong self-efficacy (Bandura, 1989). Self-efficacy is positively and significantly correlated with mathematics learning ability because this belief encourages positive learning behavior and the use of effective problem-solving strategies (Muhtadi et al., 2022; Yousuf & Rajeswari, 2024). Conceptually, this belief is built through four main sources, namely experience of success, social modeling, verbal persuasion, and emotional conditions (Bandura, 1997). Before someone can think through the process of solving a problem, he must have confidence that he is able to find a solution. Confidence in one's abilities, which comes from faith in Allah, is confirmed in the Al-Qur'an in Surah Al-Baqarah verse 286, the obligation to try to solve a problem in QS. Ar-Ra'd verse 11, the prohibition on giving up hope in facing a problem in QS. Yusuf verse 87, as well as the command to rely on trust in QS. Ali Imran verse 159, be patient QS. Ali 'Imran verse 200, and *muhasebah*. QS. Al-Hasyr verse 18. On the contrary, the level of self-efficacy often decreases due to accumulated experiences of failure in the past. Therefore, from the perspective of Islamic education, the formation of self-efficacy becomes more optimal when it is aligned with the value of *husnuzan* and the spirit of never giving up. Through this approach, students are guided to view every obstacle not as a failure, but as a means of self-evaluation (*muhasebah*) and a form of effort that is worth worship (Toshtemirova et al., 2025; Anam et al., 2026). As such, the existence of problems should encourage someone to make efforts because the human task is to try to maximize existing potential; for the results, we put our trust in Allah SWT.

Moreover, one way to foster effective mathematical problem-solving and reasoning among university students is through an optimal understanding of mathematical structure. Grasping mathematical structure and ultimately engaging in mathematical thinking helps bridge

the gap between conceptual and procedural approaches in the teaching and learning of mathematics (Mason et al., 2009). Mathematical structure lies at the heart of numerical, spatial, or logical relationships; yet, the extent to which educators understand this concept or apply it in their pedagogical practice remains unclear (Gronow, 2022). When understood, mathematical structure connects mathematical concepts and builds a robust foundation for deep mathematical thinking, which encompasses four key elements: connections to other learning (C), recognising patterns (R), identifying similarities and differences (I), and generalising and reasoning (G). Together, these components form the CRIG pedagogical framework (Gronow et al., 2020). Developing an understanding of mathematical structure is expected to enhance students' long-term capacity to transfer knowledge, engage with mathematics as a meaningful system, and effectively solve mathematical problems (Watson & Geest, 2005; Richland et al., 2012; Maryono et al., 2024).

Fundamentally, mathematical structure serves as the foundation for a structural and systematic mindset, a process closely linked to cognitive structures in the formation of schemas essential for mathematical reasoning and successful learning (Gronow et al., 2020). Through this understanding, as students construct mathematical thought structures using the CRIG framework, they indirectly develop a mindset applicable to daily life, enabling them to identify problems, analyze situations logically, and make evidence-based decisions. In various aspects of life, grasping the underlying structures of situations and phenomena becomes a vital component of problem-solving; indeed, the more knowledge and insight one possesses, the wiser one's approach to life becomes.

This mode of thinking aligns with the perspective offered by Firdaus (2021), who notes that the cognitive process begins with *ta'qilun* utilizing logic to unravel complexity and rationally identify the root causes of an issue. This is followed by *tatadabbarin*, which deepens the analysis by examining the broader context and considering long-term consequences before taking action. These stages culminate in *tatadzakkarin*, which transforms past thoughts and experiences into tangible wisdom, serving as a foundation for future decision-making. Therefore, optimizing the thought process through an IBL-CRIG framework becomes a crucial means of developing individuals capable of navigating life's challenges logically, ethically, and responsibly in harmony with the principles of *tabayyun* (verification), *musyawarah* (consultation), *ikhtiar* (diligent effort), and *tawakal* (placing one's trust in God). At a deeper level, this integration of pedagogical, cognitive, and affective dimensions must be grounded in an Islamic epistemic orientation one that emphasizes the disciplined use of intellect (*'aql*), rational reflection (*tafakkur*), and contemplative reflection (*tadabbur*) to foster the development of responsible knowledge (Al-Attas, 1977; Budiyaniti et al., 2024; Ahmed, 2026). The novel aspect of this research lies in the application of the IBL-CRIG framework to a course, the use of Ken Watanabe's and Polya's problem-solving steps, and the integration of mathematical thinking with Islamic values to optimize the problem-solving process.

The importance of possessing strong problem-solving skills and self-efficacy warrants careful examination, as both serve as fundamental pillars for success in learning mathematics. In reality, however, the critical need for Mathematical Problem-Solving Ability (MPSA) among university students is not yet matched by the current, suboptimal conditions in the field. It is essential to take steps to prepare prospective mathematics teachers who possess both strong MPSA and high self-efficacy, grounded in a solid understanding of mathematical structures. This gap is a matter of serious concern, as mathematics education within Islamic Higher Education Institutions (IHEI) demands not only cognitive agility but also the cultivation of perseverance and critical reasoning integrated with the values of Islamic epistemology (Ramadhan et al., 2026; Saputra et al., 2026). Consequently, constructive and systematic efforts

are required to optimize MPSA while simultaneously building students' self-confidence. In this regard, one strategic approach is the implementation of an Inquiry-Based Learning (IBL) model, reinforced by the CRIG framework for structuring thought; this approach is considered more effective at fostering independent thinking compared to the Direct Instruction (DI) model. This study aims to describe and compare students' mathematical problem-solving skills under the IBL-CRIG framework versus the Direct Instruction model, while interpreting the differences in their impact based on levels of self-efficacy and an Islamic perspective on problem-solving and self-efficacy.

METHOD

This study implements an Inquiry-Based Learning (IBL) model utilizing the IBL-CRIG framework, alongside a Direct Instruction (DI) model. The learning process employs the IBL-CRIG framework to enable students to grasp the substance of the course material effectively and to structure their problem-solving steps in an organized manner (Gronow, 2022). Then, students' academic self-efficacy (SE) is evaluated across four key dimensions: self-engagement, self-oriented decision-making, others-oriented problem-solving, and interpersonal climate (Yousuf & Rajeswari, 2024). The research design aims to measure the extent to which the optimized application of these learning models that incorporate inquiry methods and self-efficacy can enhance students' problem-solving abilities. An Islamic-perspective research approach integrates revelation, rationality, and empirical data to systematically and holistically map out and resolve problems (Choudhury, 2019; Rassool, 2023; Bhat & Bisati, 2025). Thus, this approach also strengthens self-efficacy by synthesizing an individual's internal potential with the value of *tawakal* (reliance on God), thereby fostering an optimistic conviction in overcoming various challenges.

Moreover, this quantitative study employs a quasi-experimental design, specifically a One-Shot Case Study (Creswell, 2012; Chen et al., 2017). The research design used is a quasi-experiment with a non-equivalent control group and a post-test-only measurement. The population consists of fifth-semester students in the Mathematics Education Study Program at UIN Sunan Gunung Djati Bandung who are enrolled in the Real Analysis course for the 2025/2026 academic year. Through purposive sampling, the sample was selected based on equivalent prior academic ability, reflected by a mean score of 60 in Differential Calculus and a standard deviation of 16 in the Selected Topics in High School Mathematics course. Given this homogeneity, Class 5A was designated as the experimental group utilizing the IBL-CRIG framework, while Class 5C served as the control group, which followed the DI model. The research instruments consist of test items for mathematical problem-solving ability (MPSA) and self-efficacy (SE), both of which have been validated internally by experts and externally through validity and reliability testing. No pretest was conducted, as there was a concern that the items used in the posttest might already be familiar to the students. Furthermore, since the subject matter real analysis is entirely new to the students, it is assumed that they possess no prior knowledge required to solve the MPSA tasks. The data were analyzed using descriptive statistics and a two-way ANOVA to examine differences in means.

In particular, the objective of this study is to analyze the impact of implementing the IBL-CRIG framework and DI models on students' mathematical problem-solving ability, with a focus on self-efficacy. Specifically, the study examines: students' mathematical problem-solving processes based on the IBL-CRIG framework and DI; the relationship between mathematical problem-solving ability and self-efficacy; differences in mathematical problem-solving achievement across varying levels of self-efficacy; and the integration of mathematical thinking with Islamic values to optimize problem-solving. A 3×2 factorial design was employed to simultaneously assess the influence of two independent variables. The first factor consists of

three levels (low, medium, and high), while the second factor consists of two levels (control and experimental groups), resulting in a total of six treatment combinations. Presenting the data in a row-and-column table format allows for an initial assessment of the trends in main effects and potential interaction effects between the two factors, which are subsequently examined in greater detail using a two-way ANOVA.

RESULTS AND DISCUSSION

Students' Mathematical Problem-Solving Ability Based on Problem-Solving Steps Using the IBL CRIG Framework

To characterize students' mathematical problem-solving abilities (MPSA) across high, medium, and low levels of self-efficacy (SE) in relation to all MPSA indicators, the first step involved categorizing SE levels. Once the SE data were collected, they were sorted and grouped into three tiers: high, medium, and low SE. In addition to determining these SE levels, the researchers also examined the students' mathematical problem-solving abilities. As a result, the data are presented to provide insight into both the students' SE levels and their MPSA. The dataset comprises 56 students, consisting of 28 students from an Inquiry-Based Learning (IBL) class using the IBL-CRIG framework and 28 from a Direct Instruction (DI) class classified according to their self-efficacy levels. Table 1 captures the numbers of students' mathematical affordances level based on class and self-Efficacy.

Table 1. Number of Students' Mathematical Problem Solving Ability Levels Based on Class and Self-Efficacy

Class	Subject	Number of Students with MPSA			
		High	Medium	Low	Total
IBL CRIG	SE High	3	1	0	4
	SE Medium	3	16	0	19
	SE Low	0	3	2	5
DI	SE High	2	3	0	5
	SE Medium	0	14	5	19
	SE Low	0	3	1	4
	Sum	8	40	8	56

According to Table 1, the high, medium and low criteria for mathematical problem-solving ability (MPSA) are determined as follows: the high category is at the interval $x > 46.79$, the medium criterion is at $(23.67 \leq x \leq 46.79)$ and the medium criterion is $x < 23.67$. The criteria for high, medium and low SE are determined as follows: the high category is at the interval $x > 109.06$, the medium criteria is at $(89.22 \leq x \leq 109.06)$ and the low criteria is $x < 89.22$.

To determine students' mathematical problem-solving ability (MPSA) based on the steps of mathematical problem-solving within the IBL-CRIG framework, students' responses to each problem were evaluated according to the problem-solving steps proposed by Watanabe and Polya: understanding the current situation, identifying the root cause of the problem, developing an action plan, executing the plan to completion, and reviewing the answer. The results regarding this ability are presented in Table 2.

Table 2. Students' Mathematical Problem-Solving Abilities Based on Problem-Solving Steps Using the IBL-CRIG framework

No.	Problem-Solving Procedures									
	1		2		3		4		5	
	Score	IMS	Score	IMS	Score	IMS	Score	IMS	Score	IMS
1	28	28	44	56	42	84	32	112	14	56
2a	36	56	34	56	19	84	18	112	8	28
2b	36	56	36	56	21	84	11	112	9	28
3	28	28	51	84	35	84	25	112	8	28
4	43	56	38	56	32	84	20	84	6	56
5a	43	56	40	56	29	84	14	84	7	56
5b	41	56	35	56	21	84	6	84	4	56
Total	255	336	278	420	199	588	126	700	56	308
%	76		66		34		18		18	

Description:

Problem-solving procedures:

1. Understanding the current situation; 2. Identifying the root cause;
3. Developing an action plan; 4. Executing the plan to completion;
5. Reviewing the answer.

IMS: Ideal Maximum Score

The maximum score for each question is 12; therefore, a student who answers correctly receives a total score of 84. Mathematical problem-solving ability is calculated based on the maximum score assigned to each step of the solution process, with question-specific adjustments made according to the level of difficulty and the recommendations of the supervisor. For the problem-solving steps, the maximum scores are as follows: 2 for understanding the current situation, 3 for identifying the root cause, 3 for developing an action plan, 4 for executing the plan to completion, and 3 for reviewing the answer.

Table 2 presents the results of an analysis of students' mathematical problem-solving abilities using the IBL-CRIG framework, evaluated based on five mathematical problem-solving steps. Overall, students demonstrated a reasonable level of competence in the initial stages: 76% were able to understand the current situation, and 66% could identify the root cause of the problem. This suggests that the IBL-CRIG framework approach is effective in helping students grasp the essence of a problem and pinpoint its primary cause. However, performance declined significantly in the stage of developing an action plan (34%), and dropped even further in the stages of executing the plan to completion (18%) and reviewing the final answers (18%). This pattern indicates that while the IBL-CRIG framework model excels at fostering conceptual understanding and initial analytical skills, it is less effective in equipping students for strategic planning, consistent execution of plans, and final evaluation.

Importantly, these findings serve as an important signal for lecturers: while the IBL-CRIG framework model offers advantages in fostering exploration and the discovery of concepts, there is a need to strengthen the higher-level problem-solving stages. This can be achieved through the incorporation of structured guidance (scaffolding) and ongoing practical exercises. In particular, the low rates of plan execution (18%) and answer verification (18%) highlight the need for interventions designed to help students independently verify their solutions and improve their ability to execute planned strategies, ensuring that their mathematical problem-solving skills are more balanced and thorough across all stages.

Based on the analysis of students' mathematical problem-solving skills using the IBL-CRIG framework and DI models, it can be concluded that both approaches exhibit a similar

trend: students perform better during the initial stages of problem-solving (understanding the situation and identifying the root cause) than in the subsequent stages (planning an action, executing the plan, and verifying the answer). Nevertheless, the IBL-CRIG framework model consistently shows higher percentages at every stage compared to the DI model. Specifically, it reached 76% (versus 71%) in understanding the situation, 66% (versus 58%) in identifying the root cause, and 34% (versus 27%) in developing an action plan. Furthermore, in the execution and verification stages, the IBL-CRIG framework model reached 18% for both, whereas the DI model achieved only 11% and 7%, respectively.

This indicates that the IBL-CRIG framework model is more effective in improving students' mathematical problem-solving abilities overall compared to the DI model, particularly in building initial understanding and problem identification, or at the stage of understanding the current situation, identifying the root of the problem, and developing an action plan. Both models still require strengthening at the execution and final evaluation stages, namely the stage of carrying out the plan to completion and rechecking the answers to achieve more optimal and balanced results at all stages of problem-solving. From a general perspective, *at-takhtith* as the planning and design stage, is still low because it is often merely a formality. *Tubsirun*, namely seeing with the eye of the heart to obtain insight and wise decisions, is also still weak because decisions are often made hastily. Likewise, *tatazakkārūn*, or taking lessons, is still low because reflection and evaluation are rarely carried out. All three need to be improved through coaching, self-awareness, and a culture of continuous evaluation.

Students' Mathematical Problem-Solving Ability Based on Problem-Solving Steps through the DI Model

To determine students' MPSA based on mathematical problem-solving steps through the DI Model, students' answers on each question item were calculated based on the problem-solving steps: understanding the current situation, identifying the root of the problem, developing an action plan, carrying out the plan to completion, and rechecking the answer. The results of this ability are presented in Table 3.

Table 3. Students' Mathematical Problem-Solving Ability Based on Problem-Solving Steps through the DI Model

No.	Problem-Solving Procedures									
	1		2		3		4		5	
	Score	IMS	Score	IMS	Score	IMS	Score	IMS	Score	IMS
1	28	28	31	56	33	84	21	112	6	56
2a	33	56	31	56	23	84	13	112	6	28
2b	32	56	32	56	21	84	12	112	3	28
3	28	28	36	84	20	84	11	112	4	28
4	36	56	34	56	22	84	9	84	2	56
5a	43	56	40	56	24	84	5	84	0	56
5b	40	56	38	56	18	84	3	84	0	56
Total	240	336	242	420	161	588	74	700	21	308
%	71		58		27		11		7	

Description:

Problem-solving procedures:

1. Understanding the current situation; 2. Identifying the root cause;
3. Developing an action plan; 4. Executing the plan to completion;
5. Reviewing the answer.

IMS: Ideal Maximum Score

The maximum score for each question is 12, so the total score for each student who answers correctly is 84. Mathematical problem-solving ability is calculated based on the maximum score for each solution step, the question numbers adjusted for weight or difficulty level, and the supervisor's suggestions. For the problem-solving step questions: understanding the current situation has a maximum score of 2, identifying the root of the problem has a maximum score of 3, developing an action plan has a maximum score of 3, carrying out the plan to completion has a maximum score of 4, and rechecking the answer has a maximum score of 3.

Based on Table 3 above, the results of the analysis of students' mathematical problem-solving ability through the DI model are presented based on the five mathematical problem-solving steps. Overall, it can be seen that students are quite capable at the initial stage, namely understanding the current situation with a percentage of 71% and identifying the root of the problem with a percentage of 58%, which indicates that they are still able to grasp the essence of the problem fairly well. However, achievement declines at the stage of developing an action plan, which only reaches 27%, and is even lower at the stage of carrying out the plan to completion at 11% and rechecking the answer at 7%. This pattern indicates that the DI model is effective in building initial understanding and identifying problems, but is less optimal in equipping students at the stage of developing an action plan, carrying out the plan to completion, and rechecking the answer.

This finding serves as an important signal for lecturers: although the DI model has advantages in delivering material in a structured manner, there is a need to strengthen the higher-order problem-solving stages by adding learning strategies that engage students more actively in learning and provide continuous practical exercises, especially since the very low implementation percentage of 11% and the near-absent rechecking at 7% indicate the need for intervention to accustom students to verifying answers independently so that their problem-solving abilities become more balanced and complete at all stages. One effort is to provide opportunities for all students to present answers independently at each meeting. In each session, there are students who discuss problems according to the topic of that meeting.

Overall, these data indicate that the DI model is effective in building initial understanding and identifying problems, but is very weak in guiding students at the stage of developing an action plan, carrying out the plan to completion, and rechecking the answer. Compared with the IBL-CRIG framework, the DI model shows lower achievement in almost all problem-solving steps, especially at the stage of carrying out the plan to completion and rechecking the answer. This indicates that the variation in learning models used in real analysis instruction, whether student-centered or emphasizing the discovery process such as IBL, tends to be more effective in developing comprehensive problem-solving skills. Therefore, strengthening is needed in learning strategies that place greater emphasis on procedural practice, providing scaffolding in formulating solution plans, and habituating independent rechecking in order to improve students' overall problem-solving abilities. From the perspective of general problem-solving, this stage becomes an effort to solve problems in a structured and systematic manner. Based on these results, the *Ta'qilūn* stage, which includes analysis and identification of the root of the problem, needs to be improved and become a primary focus in the learning process. Furthermore, the *At-takhtith* stage directs students to formulate a systematic plan for designing problem solutions. At the *Tubṣīrūn* stage, students are guided to see with the eye of the heart in order to obtain insight and make wise decisions. This series is closed with the *Tatadẓakkārūn* stage, which encourages students to take lessons from the entire process they have undergone.

Posttest Results for Mathematical Problem-Solving Ability

Descriptive data regarding the posttest results for students' mathematical problem-solving ability (MPSA) obtained following instruction using two different models, namely the IBL-CRIG framework and Direct Instruction (DI) are presented in Table 4.

Table 4. Descriptive Data for MPSA Posttest Scores under IBL and DI Models

MPSA Score	Class	Descriptive Statistics		Data
	IBL-CRIG framework	Mean		39,54
		Standard Deviation		13,03
		Minimum		20
		Maximum		69
	DI	Mean		31,43
		Standard Deviation		8,44
		Minimum		20
		Maximum		49

Based on descriptive statistics, the IBL-CRIG framework model obtained a mean MPSA score of 39.54, higher than the group with the DI approach, which only reached an average of 31.43. In addition, the data distribution in the IBL-CRIG framework group shows a wider variation, with a standard deviation of 13.03, as well as a score range from a minimum of 20 to a maximum of 69, which indicates considerable diversity in achievement among individuals. Meanwhile, the posttest results in the DI group had a smaller standard deviation, namely 8.44, with a narrower score range, namely from 20 to 49. This shows that student achievement in the DI group tended to be more homogeneous, but at a lower level compared with the IBL-CRIG group.

This finding indicates that the IBL-CRIG framework model has the potential to produce higher MPSA achievement, although with more varied result outcomes. In the stages of the IBL model, investigating various situations, conducting analysis, and providing descriptions give students the opportunity to examine the material independently. Activities that begin with reading and making summaries of the material provide opportunities for students to explore the material in a structured manner, especially by using the IBL-CRIG framework, where the stages of understanding the material are better structured.

Self-Efficacy Results

The results regarding students' self-efficacy levels were obtained through questionnaires administered after instruction using two different models: the IBL-CRIG framework model and DI. In this study, self-efficacy was measured using an instrument based on the Academic Self-Efficacy Scale (TASES) developed by Sagone and De Caroli, (2014), which comprises eleven indicators. Descriptive data on self-efficacy for the IBL-CRIG framework and DI models are presented in Table 5.

Table 5. Descriptive Data on Self-Efficacy for the IBL-CRIG framework and DI Models

<i>Classroom Self-Efficacy</i>	N	Min	Max	Mean	Standard Deviation
IBL CRIG	28	83	125	98,89	10,45
DI	28	81	113	99,39	9,54

Based on the descriptive statistics in Table 5, this study involved 28 students in the experimental class, which utilized the IBL CRIG model, and 28 students in the control class, which utilized the DI model, with all data undergoing valid analysis. In the IBL CRIG experimental class, self-efficacy scores ranged from a minimum of 83 to a maximum of 125, with a mean of 98.89 and a standard deviation of 10.45, indicating a considerable degree of variation among the students. Meanwhile, in the DI control class, self-efficacy scores ranged from a minimum of 81 to a maximum of 113, with a mean of 99.39, slightly higher than that of the experimental class. However, the control class had a lower standard deviation of 9.54, suggesting that the data in this group were more homogeneous or uniform. Although the mean scores for both classes were nearly identical, differing by only 0.5 points, the variance in the experimental class (109.14) was higher than that in the control class (91.06). This indicates a difference in the variability of self-efficacy scores between the two groups, with the scores of students in the IBL CRIG class being more dispersed or varied than those in the DI class.

The collected data were then analyzed descriptively by categorizing the combined scores of both classes the total scores of the respondents, into three levels (high, medium, and low) based on the mean and standard deviation. This mapping aims to provide a clear overview of the distribution of students' self-efficacy levels in each class. The categorization was determined by comparing the scores against the total possible scores for each self-efficacy (SE) indicator, resulting in the following classifications: "high" for a percentage score (PS) > 77 , "medium" for $60 \leq PS \leq 77$, and "low" for $PS < 60$.

Table 6. Data from the Student Self-Efficacy Questionnaire

No.	Indicator	Class			
		IBL-CRIG framework		DI	
		%	Category	%	Category
1.	Focus and Concentration	77	Medium	78	High
2.	Mental Effort	71	Medium	67	Medium
3.	Strategic Thinking	71	Medium	71	Medium
4.	Confidence in Personal Judgment	70	Medium	67	Medium
5.	Minimal Reliance on External Validation	57	Low	58	Low
6.	Acceptance of Consequences	80	High	79	High
7.	Collaboration and Communication	58	Low	60	Medium
8.	Decision-Making	80	High	78	High
9.	Support	73	Medium	69	Medium
10.	Empathy	60	Medium	60	Medium
11.	Appreciation and Trust	53	Low	63	Medium

Based on Table 6, the recapitulation results of SE score achievement on each indicator are presented for the two classes in which the approaches were applied, namely IBL CRIG framework and DI. Overall, the level of respondent achievement in both classes shows a relatively similar pattern, with score proportions varying across indicators. In the IBL-CRIG framework class, the indicators that reached the high category were acceptance of consequences and decision-making, each at 80%, which indicates that students have a good ability to accept the impact of the decisions made and are able to determine choices independently. Meanwhile, in the DI class, the indicators in the high category were three indicators, namely acceptance of consequences at 79% and decision-making at 78%, with achievement slightly lower than the IBL class.

The focus and concentration indicator actually showed higher achievement in the DI class at 78% in the high category compared with the IBL class at 77% in the medium category, although the difference was relatively small. On the other hand, the indicators of mental effort, strategic thinking, and confidence in personal judgment were in the medium category in both classes, with the IBL class achieving 71%, 70%, and 70%, slightly superior to the DI class at 67% each. This shows that although the two learning models had a balanced influence on the internal cognitive aspects of students, the IBL-CRIG framework class tended to make a slightly better contribution in building confidence in personal judgment and students' mental effort.

Although several indicators reached the high category, the data also revealed that a number of indicators were still in the low category, especially in aspects related to social interaction and external dependence. The indicator of minimal dependence on external validation was in the low category in both classes, with achievement of 57% in the IBL-CRIG framework class and 58% in the DI class. This indicates that students in both classes still depend heavily on recognition or assessment from others in evaluating their performance, so independence in self-assessment still needs to be improved. Furthermore, the collaboration and communication indicators showed a fairly significant difference, where the IBL-CRIG framework class was in the low category at 58%, while the DI class was in the medium category at 60%. Likewise, on the appreciation and trust indicator, the IBL-CRIG framework class recorded a low category at 53%, while the DI class reached the medium category at 63%.

These findings indicate that the IBL-CRIG framework model, which is intended to emphasize collaborative learning, has not yet been optimal in fostering communication skills and mutual trust among students. Consequently, there is a need to strengthen the social-affective dimension, particularly by helping students develop independence from external validation, while simultaneously enhancing the quality of their collaboration and their self-confidence in solving mathematical problems. One contributing factor is that individual students often lack full conviction regarding the correctness of their own answers; as a result, even when engaging in group discussions, they remain uncertain about the solutions they have reached for the given proof-based problems.

Differences in Mathematical Problem-Solving Ability Achievement Based on Self-Efficacy Levels

Further analysis in this study focuses on the differences in Mathematical Problem-Solving Ability (MPSA) achievement based on students' self-efficacy (SE) levels. This is because self-confidence in one's mathematical capabilities often serves as an affective variable that mediates learning success, particularly in abstract subjects such as Real Analysis. By categorizing students into high, medium, and low SE groups, this study aims to determine whether there are differences in MPSA scores among these groups, as well as to examine the interaction between the instructional methods IBL within the IBL-CRIG framework versus DI and SE levels regarding students' final achievement. The following section presents the results of comparative statistical tests, accompanied by theoretical interpretations to clarify the patterns of relationships between affective and cognitive aspects within the context of advanced mathematics instruction. Furthermore, prerequisite tests must be satisfied before conducting the primary hypothesis testing.

A normality test for MPSA achievement data across the IBL CRIG framework and DI models, stratified by SE level, was performed using the "Split File" function at a significance level of $\alpha = 0.05$. The resulting significance (Sig.) values for the six groups are as follows: IBL CRIG framework with high SE (0.055), medium SE (0.064), and low SE (0.277). Additionally, the normality test results for the DI model are: high SE (0.191), medium SE (0.173), and low

SE (0.361). Since all Sig. values are greater than 0.05, it can be concluded that the data for each group under both the IBL-CRIG framework and DI models follow a normal distribution. Consequently, the assumption of normality required for a two-way ANOVA is met. Based on the results of the homogeneity of variance test for the MPSA achievement data, Levene's test yielded significance (sig) values greater than $\alpha = 0.05$, indicating that the null hypothesis (H_0) is accepted. This implies that the MPSA achievement score data for both groups possess homogeneous variances. Levene's test results consistently showed significance (sig) values greater than $\alpha = 0.05$, further confirming that the MPSA achievement score data for both groups have homogeneous variances.

The assumptions for the two-way ANOVA, namely that the students' MPSA achievement scores from the IBL-CRIG framework and DI groups are drawn from a normally distributed population and that the variances of both groups are homogeneous, are met. Subsequently, a two-way ANOVA was conducted on the MPSA achievement scores for the IBL-CRIG framework and DI groups at a significance level of $\alpha = 0.05$. The following are the hypotheses formulated for the two-way ANOVA regarding the MPSA achievement data.

H_0 : There is no difference in the mean MPSA achievement between students who received the IBL-CRIG framework model and those who received the DI learning model, when considering their level of self-efficacy.

H_1 : There is a difference in the mean MPSA achievement between students who received the IBL-CRIG framework model and those who received the DI learning model, when considering their level of self-efficacy.

The criteria established for testing the difference in mean MPSA achievement between students who received the IBL-CRIG framework learning model and those who received the DI learning model are as follows: accept H_0 if the p-value (*sig*) $\geq \alpha = 0.05$, or reject H_0 if the p-value (*sig*) $< \alpha = 0.05$. The output from SPSS version 29 regarding the two-way ANOVA is presented in Table 7.

Table 7. Two-Way ANOVA: Self-Efficacy Level and MPSA Achievement

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3270,664 ^a	5	654,133	7,875	<,001	,441
Intercept	48716,125	1	48716,125	586,472	<,001	,921
Tingkatan_SE	1967,198	2	983,599	11,841	<,001	,321
Model	528,279	1	528,279	6,360	,015	,113
Tingkatan_SE * Model	360,172	2	180,086	2,168	,125	,080
Error	4153,318	50	83,066			
Total	77927,000	56				
Corrected Total	7423,982	55				

a. R Squared = ,441 (Adjusted R Squared = ,385)

Based on the results of the two-way ANOVA test that has been carried out, the hypothesis decision shows that H_0 the learning model is rejected or H_1 is accepted, because the significance value of 0.015 is smaller than 0.05, which means there is a significant difference in the average MPSA achievement between students who received the IBL-CRIG framework model and the DI model. Likewise, H_0 for self-efficacy level is also rejected because the significance value is less than 0.001, so there is a significant difference in the average MPSA achievement among low, medium, and high SE levels. However, H_0 The interaction between

learning model and self-efficacy level is not accepted because the significance value of 0.125 is greater than 0.05, which indicates that there is no significant interaction between the two variables. Thus, it can be concluded that the difference in average MPSA achievement between the IBL-CRIG framework model and the DI model is proven to be significant and consistent at each self-efficacy level.

There is a positive and significant correlation between SE ability and MPSA with an effect value of 9.73%, but SE level with MPSA has an effect value of 32.10% on MPSA attainment. The results of the study show that both SE ability and SE level are positively and significantly correlated with mathematical problem-solving ability. SE level provides a much more dominant contribution of 32.10% because confidence and mental resilience encourage students to persevere in solving complex problems. Conversely, SE ability contributes 9.73%, which indicates that having the indicators of SE ability theoretically does not automatically improve student performance if it is not accompanied by a strong level of self-confidence when solving problems. Therefore, lecturers need to focus on building students' SE level in addition to training mastery of substantive material and logical and analytical thinking.

Integration of Mathematical Thinking and Islamic Values in Optimizing Problem-Solving

The implementation of learning outcomes is marked by attitudes or behavior directed toward improvement. Learning mathematics seeks to optimize thinking to the maximum, especially since mathematics is a structured science that is expected to have an impact on maximum efforts in problem-solving. Training in mathematical problem-solving ability is expected to have an impact on the problem-solving abilities that will be faced in real life (Siswanto & Meiliasari, 2024). To solve problems, whether mathematical or otherwise, a method or stages for solving them are certainly needed. One of these is optimizing the thinking process by strengthening a good thinking structure. This means that, to solve problems, one's thinking ability must first be strengthened. After that, recognize the problem-solving steps. The aspects of thinking, reasoning, and constructing proofs mean optimizing the intellect to the maximum (Schoenfeld, 2006). In the Islamic perspective, problem-solving ability and proof construction are fundamental needs, because Islam commands humans to use their intellect optimally through *tafakkur*, *tadabbur*, and *ta'aqqul* in QS. Ali Imran: 190-191, so that a Muslim is trained to think systematically, critically, and evidence-based in facing life's problems. Studying proofs is not merely proving that something is true, but believing in the truth of something with a specific foundation and rules. For example, in constructing a proof, it must be followed by logical and theoretical reasons, one of which is in accordance with the appropriate definitions, axioms, and theorems. This ability also becomes a fortress against blind imitation (*taqlid*) and prejudice, because the construction of proof requires every claim to be supported by valid arguments, in line with the principle of *tabayyun* in QS. Al-Hujurat: 6 and the prohibition of prejudice in QS. Al-Hujurat: 12.

The Quran calls upon human beings to think, reflect, and employ their intellect. Verses containing such invitations expressed through various linguistic forms number approximately 130 to 150 (Abnisa, 2024). The capacity for thought is what distinguishes humans from other creatures. Descartes (1590–1650 AD) famously stated, "I think, therefore I am." This assertion establishes that thinking serves as proof of human existence as conscious beings endowed with reason. Thinking is a process involving symbolic meanings that occurs within the cognitive realm when an individual encounters a problem. This process comprises four elements: the existence of a problem, the impressions received, the functioning of the senses, and the knowledge one already possesses (Damayanti, 2026). Various terms related to the concept of

thinking in the Quran correspond to specific stages in the problem-solving process; these connections are explained (Choudhury, 2019; Firdaus, 2021; Rassool, 2023) as follows:

1. *Tanzurūn* (sensory observation): the stage of observing and gathering data.
Before a problem can be resolved, one must observe the actual situation. *Tanzurūn* serves as the initial step, involving the collection of facts, phenomena, and empirical data. Problem-solving that is not grounded in careful observation rests merely on assumptions (Imronudin, et al., 2026). This aligns with the first step proposed by Ken Watanabe: understanding the situation at hand.
2. *Ta'qilūn* (the use of logical reasoning): the stage of analysis and identifying the root cause of a problem. Once data has been gathered, the intellect is employed to analyze the primary causes and the relationships of cause and effect. *Ta'qilūn* refers to a process of rational reasoning capable of distinguishing symptoms from the root causes of a problem (Aulia et al., 2026). This aligns with Watanabe's second step: identifying the root cause.
3. *At-takhtith*: the stage of planning, designing, or outlining. In Islamic management, *at-takhtith* involves defining the objectives one intends to achieve.
4. *Tatadabbarūn* (delving into meaning): the stage of understanding context and consequences. A problem should not be analyzed superficially; rather, its meaning, context, and long-term implications must be explored in depth. *Tatadabbarūn* requires a comprehensive understanding, encompassing the implications of potential solutions and the underlying objectives (Damayanti, 2026). This corresponds to the third step: developing hypotheses and contextually relevant solutions.
5. *Ta'lamūn* (possessing knowledge): the stage of mastering information and reaching conclusions. Following a rigorous thinking process, one arrives at a clear understanding of the causes of a problem and its potential solutions. *Ta'lamūn* represents a cognitive outcome a verified understanding. This aligns with the step of concluding, which involves establishing a diagnosis or a final determination.
6. *Tubṣirūn* (seeing with the "eye of the heart"): the stage of gaining insight and making wise decisions. Not all problems can be resolved through cold logic alone; *bashirah*, the "eye of the heart," is required to perceive deeper wisdom and insight. *Tubṣirūn* is the capacity to discern solutions that are ethically and spiritually sound. This aligns with the decision-making phase: selecting the optimal solution that yields *maslahat* (benefit/well-being).
7. *Ulū al-Albāb* (the quality of possessing a pure, discerning intellect): the stage of evaluation and intellectual maturity. The culmination of this entire process is becoming an *ulū al-albāb* an individual who not only solves problems but also learns, grows, and gains greater wisdom. Such individuals, upon resolving a problem, find themselves with a deeper knowledge of God and greater maturity in their actions. This aligns with the final step: evaluation, self-reflection, and continuous improvement.

The Qur'anic terms for thinking are not merely theological concepts but form a complete framework for problem-solving: starting from observation (*tanzurūn*), analysis (*ta'qilūn*), deepening of meaning (*tatadabbarūn*), reflection (*tatadzakkarūn*), mastery of knowledge (*ta'lamūn*), insight (*tubṣirūn*), to maturity of thinking (*ulū al-albāb*). This framework is in line with modern problem-solving methods such as Ken Watanabe's, but adds a spiritual and ethical dimension that makes solutions not only effective but also blessed and responsible.

When someone successfully passes through a systematic thinking process starting from observing, analyzing, formulating hypotheses, testing, and concluding, that success becomes a mastery experience, namely the strongest source of self-efficacy. According to Bandura, the more often a person successfully solves problems through a thinking process, the stronger their self-confidence becomes (Bandura, 1997; Abd Al-Mayahy, 2026). Ibn Sina in *Al-Isyarat wa al-Tanbihat* describes that true belief arises from verified knowledge, not from mere conjecture

(Ula et al., 2026). This principle enriches the concept of self-efficacy as Allah emphasizes in the QS Al-Baqarah verse 186: call upon Allah with the conviction that He will answer. The verse also ends with the command so let them respond to Me and believe in Me. This shows that the belief intended is not merely passive belief, but belief accompanied by obedience and active faith. This is reinforced by the Prophet's hadith, narrated by Tirmidzi: Call upon Allah with the conviction that He will answer. Know that Allah does not answer a supplication from a heart that is heedless and not serious. This hadith emphasizes that a heedless and unserious heart (*qalb ghāfil lāh*) becomes an obstacle to the answering of supplication. In the self-efficacy perspective, a heedless heart describes cognitive absence or lack of focus on the problem, weak self-regulation (inability to manage attention), and motivation deficiency (no seriousness in effort). This condition weakens self-efficacy because a person does not have full awareness of the problem being faced. Strong self-efficacy requires good self-regulation, including the ability to concentrate attention, manage emotions, and maintain motivation (Supriyati, 2026).

The stories of the prophets in the Quran serve as the most authentic lessons on self-efficacy. Belief in one's own capabilities is not a form of arrogance; rather, it is the awareness that Allah has bestowed capacity and assistance upon His servants, and that He does not burden any soul beyond what it can bear. Self-efficacy fosters individuals who are courageous in their thinking, persistent in their efforts, patient when facing trials, and reliant upon Allah (*tawakal*) regarding the outcomes. Islamic scholars exemplify this form of self-efficacy, as their belief in their own abilities is rooted in faith, knowledge, and *tawakal*. Long before the formulation of modern methodologies, they addressed problems through systematic approaches, verification, and innovation. Such robust self-confidence is not mere baseless optimism; it is the result of mastering knowledge, rigorous verification, and a proven track record of successfully resolving challenges.

This principle teaches that any proposed solution must be tested and validated before it is embraced, ensuring that self-confidence rests upon a solid foundation, not merely on assumptions. Consequently, by anchoring one's confidence in the power of the intellect a gift from Allah, extraordinary works are brought into existence (Yudiyanto et al., 2024). When these approaches are applied to contextual problem-solving addressing real-world issues bound by specific situations, values, and social impacts, a synthesis emerges that is not only technically effective but also ethical and spiritual. Thus, the optimization of thought within an Islamic framework transcends simple, intelligent, and systematic reasoning; it is thinking grounded in righteous intentions, honest processes, consultative decision-making as prescribed in Surah Ash-Shura: 38, maximum effort followed by *tawakal* as in Surah Ali 'Imran: 159, and continuous self-reflection (*muhasabah*). Through this, every contextual problem can be addressed in an optimal and sustainable manner.

CONCLUSION

The results of this study conclude that the Inquiry-Based Learning model with the IBL-CRIG framework is proven to be more effective than the Direct Instruction (DI) model in achieving the mathematical problem-solving ability (MPSA) of mathematics education students at Islamic higher education institutions. The superiority of the IBL-CRIG framework is consistently reflected in every problem-solving step, especially at the planning, execution, and evaluation stages that require higher-order thinking skills. The results of statistical tests confirm a significant effect of the learning model with a medium effect size, as well as a more dominant influence of self-efficacy (SE) on MPSA, without any interaction effect between the two, so that the superiority of the IBL-CRIG framework applies consistently at all SE levels. This indicates

that improving MPSA requires a holistic approach that integrates innovation in learning models with simultaneous strengthening of students' affective aspects.

Mathematics learning seeks to optimize a systematic thinking process that is in line with the Qur'anic command to use the intellect to the maximum. By thinking maximally and in a well-structured manner before solving problems. The stages of thinking in the Islamic perspective, from observation and analysis to evaluation, are in line with modern problem-solving methods. Success in passing through this structured process is capable of building self-efficacy or self-confidence based on verified knowledge. Ultimately, the integration between technical ability and the spiritual dimension gives birth to contextual problem-solving solutions that are effective and sustainable. Future research is suggested to expand the scope to other cognitive abilities by involving other moderator variables such as learning motivation, cognitive style, or prior ability in order to explore more complex interactions in improving MPSA. A mixed-methods approach can be used to gain a deeper understanding of students' thinking structures during learning.

AUTHORSHIP CONTRIBUTION STATEMENT

HS: conceptualization, data collection, writing the original draft. SF: data validation, methodology, supervision. JAD: methodology, interpretation of results and discussion, supervision. KN: data validation, methodology, supervision.

CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest related to the research, authorship, or publication of this manuscript.

GENERATIVE AI STATEMENT

During the preparation of this manuscript, the authors used DeepSeek for reviewing the discussion and improving readability.

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