Interplay of Cognitive Strategies and Self-Efficacy in Engineering Problem Solving

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Abstract

Students' belief in their own problem-solving abilities is crucial to how they plan, monitor, and regulate their cognitive processes during complex engineering problems. Although prior research found a strong connection between students' performance outcomes and confidence in their problem-solving abilities, little is known about how this confidence translates into an observable reasoning process. This study examines how students' pre-problem confidence relates to the cognitive strategies they employ during engineering problem solving and how these strategies connect to students' post-problem accuracy judgments.

The participants were recruited from an undergraduate engineering course at a land-grant public university in the western United States. Before starting the task, students rated their confidence level in solving the problem successfully, from very confident to no confidence. Students expressed their reasoning and reflections while solving problems, providing real-time insight into cognitive and metacognitive awareness about the task. After completing the activity, participants assessed the accuracy of their answer (correct, partially correct, or incorrect) and justified their level of certainty about their judgment. These problem-solving activities were audio recorded, and the audio data were transcribed and analyzed thematically using an open coding process that captured patterns of strategy use, monitoring behavior, and epistemic viewpoint.

Findings revealed that students with higher self-efficacy demonstrated proactive monitoring, systematic reasoning, and persistence in addressing conceptual deadlocks. However, students with lower self-efficacy exhibited reactive strategies, early closure in reasoning, and limited self-checking. These findings highlight that self-efficacy dynamically transforms cognitive involvement throughout problem solving in addition to influencing initial confidence. This research contributes to engineering education research by shedding light on the interplay between cognitive regulation and motivational beliefs. It stresses the significance of cultivating self-efficacy to improve problem-solving flexibility and reflective judgment.

Keywords: Problem solving, self-efficacy, cognitive strategies, Achievement Goals

I. Introduction and Background

Engineering problem-solving is an important cognitive activity in engineering education that requires students to engage in strategic reasoning, monitor their progress, and evaluate the correctness of emerging solutions. While cognitive processes in engineering problem solving have been extensively studied, far less attention has been given to how these processes interact with affective–motivational factors such as students' confidence and self-efficacy [1]. According to Jonassen [2], both cognitive and affective factors internal to the problem solver influence the development of problem-solving skills. Similarly, Wood et al. [3] also argued that for many complex engineering tasks, the cognitive demands of developing, testing, and selecting solution strategies require a strong belief in one's capability to process information effectively and to choose appropriate courses of action. Bandura [4] defined this capability in terms of self-efficacy as "People's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances." Specifically, higher engineering self-efficacy has been shown to predict greater learning and conceptual understanding in introductory engineering courses [5]. This effect of self-efficacy on learning is mediated by cognitive processes involved in the development, testing, and selection of problem-solving strategies [6]– [7]. Bandura further explained the effect of self-efficacy on performance in terms of cognitive regulation. Individuals with a strong sense of efficacy set higher goals, commit more firmly to them, and generate anticipatory success scenarios that guide their actions. These beliefs enhance cognitive processing by enabling learners to construct options, evaluate information, and monitor their judgments effectively, even under uncertainty. In contrast, low self-efficacy is associated with failure-oriented thinking, lowered aspirations, and inconsistent analytical processing, particularly when tasks become challenging [8]. This cognitive mechanism provides a foundation for examining how students' task-specific confidence may shape the strategies they use and the quality of their reasoning during complex engineering problem solving. Building on this association, this research aims to explore the interplay between cognitive strategies and students' perceived self-efficacy before and after solving the problem.

Following Bandura's seminal conceptualization of self-efficacy [9], a substantial body of research has demonstrated the relationship between students' academic self-efficacy and cognitive achievement in terms of learning, motivation, and academic performance [10]– [12]. The literature also suggests that it is the motivational component of self-efficacy that drives academic performance [13]– [15]. According to Köseoğlu [15], self-efficacy is a key motivational construct that shapes how students engage cognitively with academic tasks. He demonstrated that students with higher self-efficacy not only achieve higher academically but also adopt mastery-oriented goals, use deeper cognitive and metacognitive strategies, and regulate their effort more effectively. Similarly, Komarraju and Nadler [16] also showed that self-efficacy not only predicts academic performance but is closely tied to students' beliefs, goals, and learning behaviors. Building on this relation between self-efficacy, goals, and performance, this research aims to explore how students' task-specific self-efficacy interacts with their cognitive strategies before, during, and after solving an engineering problem, and how these patterns differ between mastery-oriented and performance-oriented students**.** In this study, pre-problem confidence is conceptualized as an affective–motivational belief related to self-efficacy, whereas students' expressions of certainty or uncertainty in their post-problem explanations reflect epistemic affects associated with knowledge evaluation and sense-making. Achievement goal theory (AGT) provides a conceptual base for examining how students' performance and mastery-oriented goals shape their engagement during problem-solving activities. AGT provides useful grounding for interpreting both quantitative data on students' achievement goal orientations and qualitative evidence of their engagement that enables connecting emerging patterns in the data to an established body of theoretical work.

II. Purpose of the Study

The purpose of this study is to examine how students' task-specific self-efficacy interacts with the cognitive strategies they use during solving an engineering problem. Drawing on Social Cognitive Theory, the study explores how pre-task confidence or perceived self-efficacy, reasoning processes during problem-solving, and post-task certainty judgments relate to one another, and how these patterns vary between mastery-oriented and performance-oriented students. The following research question guides this study: *How does students' pre-task* *confidence influence the cognitive strategies they use and their post problem-solving evaluation of correctness while solving engineering problems?*

III. Methods

A sequential explanatory mixed-method research design was employed, consisting of a quantitative phase followed by the qualitative phase [17]. During the quantitative phase, 103 participants completed the Achievement Goal Orientation questionnaire. Participants were recruited from an undergraduate engineering course within the college of engineering, and participation in this study was voluntary. Participants were classified as mastery goal-oriented (MGO) or performance goal-oriented (PGO) based on their responses. In the qualitative phase, eight students were purposefully selected to participate in a problem-solving task, including four MGO and four PGO students. The approach reflects mixed method integration at the selection level, and the interpretation of findings across quantitative and qualitative phases represents integration at the interpretation level, allowing the qualitative data to elaborate and provide depth to the patterns emerging from the quantitative results. Participants were presented with an electronics circuits problem-solving task from the "fundamental electronics for engineers" course to evaluate their problem-solving strategies and engagement.

A. Data Collection

The 12-item Achievement Goal Questionnaire–Revised (AGQ–R), developed and validated by Elliot and Murayama [18], was used. AGQ-R is a validated instrument widely applied in motivation and engineering education research to capture dispositional goals that shape students' engagement during problem solving. The instrument contains multiple subscales measuring mastery-approach and performance-approach goals, with responses recorded on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Subscale scores were used to classify students as mastery-oriented or performance-oriented for subsequent analyses.

Before beginning the problem-solving task, students indicated whether they had previously encountered the same or a similar problem (yes/no) and reported their initial confidence level (very confident, confident, less confident, or not confident). During the task, a think-aloud protocol was employed to capture participants' reasoning and strategy use in real time. After completing the problem-solving task, students evaluated the accuracy of their solution (correct, incorrect, or partially correct) and responded to an open-ended prompt explaining why they felt sure or unsure about their answer. These data were analyzed qualitatively to examine the interplay between students' perceived self-efficacy before and after the task and the cognitive processes evident during problem solving. All sessions were audio-recorded, transcribed, and independently verified by two researchers to ensure accuracy and reliability.

B. Data Analysis

Data collected from the AGQ-R questionnaire were analyzed using descriptive statistics. Based on those descriptives, students were classified as mastery goal-oriented (MGO) or performance goal-oriented (PGO) by comparing their AGQ-R subscale scores. Participants whose mastery-approach score exceeded their performance-approach score were categorized as MGO, whereas those with higher performance-approach scores were categorized as PGO. Qualitative data collected from the problem-solving activity was transcribed using the MAXQDA transcription services. The transcribed data were analyzed using inductive thematic analysis. Inductive coding was conducted following Saldaña's [19] approach through an iterative process of coding, categorizing, and theme development. Through iterative cycles of memoing and reformation, these patterns were synthesized into broader themes that represent common processes across participants. The researcher's positionality as an engineering educator and familiarity with student problem-solving processes were acknowledged and reflected upon to ensure that the interpretation of themes remained grounded in the data rather than predetermined assumptions. Two researchers independently coded the data using MAXQDA and then collaboratively refined the codes and themes through analytic discussion. Inter-rater agreement exceeded 90%, established through a peer debriefing process [20].

IV. Findings

AGQ-R survey data were used to classify the participants into mastery goal-oriented (MGO) and performance goal-oriented (PGO) groups based on their mean scores. Participants whose mastery-approach mean score exceeded their performance-approach score were categorized as MGO, whereas those with higher performance-approach scores were categorized as PGO.

Table 1*: Descriptive Statistics of Achievement Goal Orientation*

	N	**Mean**	**S. D**	**Variance**
Mastery Goal Orientation	103	4.19	0.74	0.550
Performance Goal Orientation	103	3.81	0.85	0.72
Achievement Goal Orientation	103	3.78	0.60	0.36

Four major themes were developed for each case of MGO and PGO students to answer the research question.

Case 1: Mastery Goal-Oriented Participants

All four MGO participants reported having seen a similar problem before. Among the mastery-oriented students, three expressed confidence, and one reported low confidence before beginning the task. These initial confidence levels provide a useful lens for interpreting the cognitive strategies and reasoning patterns observed during problem solving. In addition to reporting their initial confidence, students also evaluated the correctness of their solutions after completing the task. Their post-task perceptions varied: among the mastery-oriented students, two believed their solutions were partially correct, and two reported a correct solution. These post-problem judgments, when considered alongside students' initial confidence levels, provide important context for understanding their cognitive strategies and their interplay with their perceived self-efficacy.

Theme 1: Analytical Problem Framing Anchored in Conceptual Knowledge

The MGO students began by conceptually framing the problem, rather than applying the formulas immediately. They spent some time analyzing the circuit, mentally mapping the solution, and simplifying the complexity. For example, one of the participants stated:

> *" My first instinct is to look at the way the circuit's going to look at each position of the switch. So right now, it's no current or voltage at any point... I feel like I should just draw out what those will be."*

Here, the participant is mentally stimulating the circuit behavior through planning and then by drawing before diving into the mathematical analysis. Another participant also exhibited the same cognitive approach as, "First I will look at what would have been happening if it's been at steady state in position one… which means that the inductor will be behaving as a short circuit.". The participants were trying to make sense of the problem with careful planning before engaging with the execution using formulas. Once they planned, they started drawing of the circuit to map their planning process as, "Okay, so I'm going to actually redraw the circuit really quickly. just to take out the stuff that doesn't exist when there is uh…When the circuit is open." This shows their process of problem solving from mental mapping towards drawing to simplify the ambiguous part of the problems as the participant was saying to remove the elements of the circuit from the part where the circuit was open. As most of the MGO participants were confident before solving the problem, that confidence appeared to be tied to their self-efficacy, which was grounded in prior experience with similar tasks and a strong sense of conceptual understanding.

Theme 2: Adaptive Strategy Refinement

A notable strategy of MGO participants was their willingness to make revisions and adjustments to their strategy. They monitored their understanding, revised their steps by redrawing circuits, and used alternative reasoning when uncertainty arose. They did not abandon the task by just trying once, but were motivated to do multiple iterations, being a mastery-oriented participant. As one of them mentioned, "I think I jumped to a couple of conclusions before actually kind of trying to understand the circuit… once I kind of got over that fear, it just flowed." and another said " I need to take a step back and think about what I'm looking at here… I realized that I didn't need to be doing that at all." illustrates that participants' ability to pause, reassess, and revise their approach. This moment reflects a key aspect of adaptive strategy refinement: the student recognizes that their initial line of reasoning may not align with the problem's conceptual demands, prompting them to mentally reset and reconsider the structure of the circuit. Similarly, another MGO participant said, "I believe I messed up in the calculation of the resistance of the Thevenin circuit, which will be an easy fix. Let me just verify this." Here, the participant persists in correcting the mistake by using it as an opportunity rather than a barrier. Such kind of confidence was also evident from the following excerpt:

> *"I just realized that I didn't need to be doing that at all because I had to find the current I2 at equals zero plus, which is just the initial current. So, um. the current doesn't change instantaneously. Therefore, it was just to that 0.24 amps that I had. So I guess that's what my answer will be there."*

This provides a clear example of participants' recalibration during problem solving. Through the self-reflection, the participant recognized what principle was overlooked. This constructive engagement behavior of participants is consistent with their MGO profiles. Here, participants' self-efficacy fluctuated during the problem-solving. Whenever they felt uncertainty, they used it as a cue to regulate their strategy, consistent with Bandura's notion of efficacy-activated cognitive control.

Theme 3: Conceptual Model Application

A prominent strategy observed among MGO participants was the deliberate use of idealized component models to reason about the circuit behavior. Rather than relying on formula-driven approaches or procedural calculations, participants invoked conceptual models of electrical components to simplify the circuits and constrain possible solutions. This strategy reflects how they were using component behavior representations to predict system behaviors and guide further problem-solving steps. For example, they consistently reasoned about the circuit behavior by distinguishing between different temporal states (e.g., steady state, $t = 0^+$, and $t = \infty$) as, "If it's been a steady state, then the inductor will be behaving as a short circuit." and "Our inductors are at steady state, so it was basically a short circuit". They used idealized steady-state behavior to reduce the cognitive load.

They also reasoned about the circuit behavior immediately after switching, for instance, "At t equals zero plus, the inductor would act as an open circuit." Here, the participant was reasoning qualitatively using model-based inference about the circuit before performing the numerical calculations. At some places, MGO participants also used constraints associated with idealized models to avoid unnecessary computation: "The current doesn't change instantaneously… so it was just the 0.24 amps that I had." This moment illustrates how idealized models were used as decision-making tools during their problem-solving activity.
MGO participants trusted conceptual models over complex or exhaustive computations, which supported their self-efficacy in problem solving. Importantly, this confidence did not result in superficial reasoning; instead, it supported principle-driven inference.

Theme 4: Self-efficacy Driven Post-solution Judgement

After completing the problem, MGO participants were engaged with their self-evaluation regarding the correctness of their solution. Most participants' response was grounded in an appraisal of their reasoning process, conceptual understanding, and procedural reliability rather than in absolute certainty. They demonstrated explicitly why they were sure, unsure, or partially confident about their solutions, as:

> *"The way I got to the answer was, you know, kind of fun, kind of cool And nothing that seemed like way over my head. So I'm like, oh. This seemed like feasibly this must be the correct answer, because I got to it in a way that makes a lot of sense. And wasn't just like shooting from the hip."*

The participant was confident about the solution and judged it through the quality of cognitive engagement, not merely through computational verification. This participant initially approached the task with limited confidence; however, his post-problem evaluation reflected a substantial rise in self-efficacy. After completing the problem, he described his solution path as logical, manageable, and even enjoyable, which led him to feel more certain about the correctness. Similarly, another participant expressed doubt in terms of computational and tool-related error like calculator input, rather than conceptual misunderstanding as "Maybe I entered some numbers wrong… I wouldn't bet my life on it, but I feel like it's at least partially correct.". Although the student entered the task with high confidence, his post-solution evaluation revealed doubt in procedural error, but still confident in the conceptual approach. Hence, the mastery-oriented students demonstrated calibrated evaluative judgment, expressing confidence or uncertainty based on the coherence of their reasoning, awareness of procedural limitations, and openness to revision rather than absolute certainty.

Case 2: Performance Goal-Oriented Participants

All four PGO participants reported having seen a similar problem before, yet their confidence levels before solving the problem varied. Two participants entered the task feeling confident, whereas the other two reported less initial confidence. After solving the problem, none of the PGO participants were very confident in their solutions except one student, who clearly labeled the result as incorrect. Four major themes were developed based on their problem-solving data and their qualitative response to the correctness of their solution after completing the problem, to analyze how the cognitive strategies used interact with their perceived self-efficacy.

Theme 1: Reliance on Procedural Heuristics

PGO participants frequently used procedural strategies, including formula recall without deeply anchoring their reasoning in conceptual understanding. They relied mostly on known procedures to get an answer, rather than building any conceptual mental model of circuit behavior. The formula-driven reasoning resulted in shallow engagement despite having uncertainties. For instance:

> *"I know I messed up a theorem somewhere because the value didn't align with what I thought it was… Maybe I had the wrong mentality when using the theorem and that probably messed it up. And that just kind of cascaded."*

Here, the participant frames the failure in procedural terms as recalling a theorem, rather than questioning underlying assumptions about circuit behavior. Similarly, other PGO participants proceeded by making assumptions and applying procedures without validating them. For example, one of the participants described uncertainty rooted in assumptions as, "I'm not sure I redrew it correctly… there's lots of assumptions in there. If my assumptions were correct, I feel okay." The participant's confidence centers on whether the assumption is correct rather than justifying it through conceptual reasoning. Another participant's confusion, tied to an incorrect assumption about circuit behavior, was evident when he said, "Just the assumption that I made about the shorted circuit… when it was put to position two, it kind of threw me off." This reflects that once an assumption failed, the procedural pathway lost coherence, leading to decreased confidence.

Theme 2: Surface-level Interpretation without Deep Structural Modeling

PGO participants were mostly engaged with surface-level interpretation without constructing a deeper conceptual model of how the circuit behaves under different conditions. Their reasoning was tied more to the apparent structure of the circuit rather than how it functions. Resultantly, their reasoning was grounded in surface features rather than the principles governing circuit behavior. One of the participants exhibited this behavior as, "I guess. There's no current going through the resistor anymore. It's a 10-ohm resistor And let's see what else can I say?". Another participant said, "I'm not sure I redrew it correctly, there's lots of assumptions in there." Here, redrawing the circuit is not merely a visual task; it requires applying structural principles. Without constructing a mental model of how the circuit actually operates after the switch, the participant cannot determine whether the redraw preserves functional equivalence. Thus, the PGO participants demonstrated a surface-level cognitive strategy: relying on visual layout and unverified assumptions instead of conceptualizing the underlying electrical relationships.

Theme 3: Managing Uncertainty Through Evaluative Reasoning

Despite the absence of consistent constructive engagement during problem-solving, PGO participants navigated uncertainties through procedural strategies. For example:

> *"And so I'm just going to test it and plug that in to my calculator to remember which One. I'm supposed to use. Whether it's one minus e to the negative t over, tau over or just e to the negative t over tau Okay. And then trying the other way."*

The participant was using trial-and-error evaluation rather than conceptual reasoning. The participant did not verify the concept but viewed both versions to achieve an acceptable result. PGO participants showed episodic self-questioning or fragmented checking to survive through the confusion, holding unresolved ambiguity. Across all PGO participants, uncertainty did not derail reasoning but shaped the way they reasoned: students gauged correctness by assessing whether their steps felt plausible, whether numerical values looked reasonable, or whether assumptions seemed acceptable. This evaluative strategy allowed them to continue working despite conceptual gaps, but it also contributed to fragile confidence when their evaluations conflicted with final results.

Theme 4: Post-Problem-solving Self Efficacy Constrained by Procedural Correctness

The confidence of PGO participants after solving the problem was not shaped by their conceptual understanding but by their evaluation of whether their procedures, steps, assumptions, or formulas were correct. This shows that their self-efficacy was weak and dependent on perceived procedural accuracy. For example, one of the participants was not sure about the assumption made as,

> *"just the assumption that I made about the shorted circuit, it's just the um that it not that it was open, but that it was at position one When it was put to position two, it kind of is throwing me off So that's why I only say partially correct. Okay."*

When the assumption becomes questionable, self-efficacy immediately weakens. Similarly, another participant mentioned that the theorem was misapplied, due to which the result may be wrong as “I know I messed up a theorem somewhere… the value didn’t align with what I thought, so I’m pretty sure the end result is wrong.” Another participant said, “The problem-solving process is correct, and the equations might not be 100% correct, I don’t remember between inductors and capacitors, but I think it is partially correct.” Together, these responses show that PGO participants’ self-efficacy after solving the problem was constrained by how correct they believed their procedural actions were, not by the strength of their conceptual reasoning. When procedures felt uncertain, whether due to mistaken assumptions, misapplied theorems, or unclear equations, their self-efficacy dropped sharply, resulting in partial certainty or complete doubt.

V. Discussion and Conclusion

This study examined how the engineering student’s task specific self-efficacy interacts with the cognitive strategies they use during the problem solving, focusing on differences between MGO and PGO students. The findings reveal a clear distinction between PGO and MGO participants’ self-efficacy and use of cognitive strategies across the stages of problem solving. MGO participants were mostly confident in pre- and post-problem solving, and their response about correctness was grounded conceptually. This high self-efficacy may therefore lead to deeper cognitive processing, cognitive engagement, and persistence in challenging tasks [21]. The MGO students exhibited cognitive strategies of analytical problem-solving, iterative strategy refinement, and conceptual model application. These behaviors of MGO participants are consistent with the previous research regarding mastery goals, students use deep and adaptive cognitive strategies in solving complex problems to deal with the uncertainty [22]– [23]. Hence, higher self-efficacy and deeper cognitive processing lead to higher constructive engagement [24]– [25].

These results also align with Bandura’s Self-Cognitive Theory [4], self-efficacy influences both motivation and engagement. MGO participants’ belief and confidence in performing the activity led them to successful execution. Several empirical studies have shown that self-efficacy is associated with positive student outcomes, including higher use of cognitive strategies [26]– [27]. This aligns with the present study’s findings, which indicate that students with higher task-specific self-efficacy, particularly those with mastery goal orientations, engaged more frequently in deep, adaptive cognitive strategies. It is also worth acknowledging that the variance observed within the mastery goal–oriented group cannot be explained by goal orientation alone. Self-efficacy emerged as an additional differentiating factor, as argued by Abideen [28]. Additionally, this relation of mastery goal orientation to self-efficacy and then to cognitive strategies was also reflected in their final solutions; MGO participants produced mostly correct answers, and their post-task self-efficacy was reinforced by the fact that their strategies were grounded in conceptual understanding rather than mere procedural execution.

While PGO participants’ confidence or perceived self-efficacy before solving the problem reflects that they were partially confident in problem-solving correctly, and then after solving the problem, they perceived their solution to be either incorrect or partially correct. Their post-problem evaluations of solution correctness indicate that their confidence was largely performance-driven, relying primarily on perceived procedural accuracy rather than being grounded in conceptual understanding. In terms of the use of cognitive strategies, PGO participants relied heavily on procedural heuristics, surface-level interpretation of circuits, and trial and error to manage uncertainty. These strategies reflect active rather than constructive engagement [25], consistent with the performance-oriented learners who prioritize outcomes over conceptual understanding [29]. That active engagement was based on analytical reasoning, not dealing with ambiguity with conceptual understanding, but still striving to reach a solution.

According to Abideen [28], the mismatch between the task complexity or demands and their motivational profile (here, PGO) triggers the disengagement, especially at moments of ambiguity, where they try to use memorized procedures without understanding. Hence, before solving the problem, they were partially confident, but after going through the complexity during problem-solving, they were sure that their solutions were partially correct or incorrect, mainly because of incorrect procedures, assumptions, and calculations. Their cognitive strategies did not provide them enough confidence to validate their solutions, leaving their self-efficacy highly dependent on whether they believed their procedural steps were correct. Before solving the problem, the PGO participants expressed confidence because they relied on familiar, memorized procedures. However, this confidence quickly reduced when they encountered uncertainty, as their dependence on procedural recall, rather than underlying conceptual understanding, left them without the cognitive resources needed to resolve unexpected difficulties. This relation between their cognitive strategies, self-efficacy, and goal-orientation profile was also evident in their final solutions; PGO participants solved the problem mostly incorrectly, and their post-task self-efficacy was attributed to perceived procedural errors, uncertain assumptions, and doubts about whether they had applied the correct steps. Their self-efficacy was strictly tied to surface-level strategies, a pattern consistent with prior research on performance goal-oriented students who rely on procedural success to sustain confidence [29].

This study demonstrates that engineering students' problem-solving self-efficacy is deeply intertwined with their cognitive strategies and achievement goal orientation profiles. The findings provide clear evidence that MGO and PGO participants are engaged in different forms of cognitive work that shape their self-efficacy. The research highlights that students' cognitive engagement cannot be understood without accounting for their motivational profiles and self-efficacy beliefs. These findings contribute to engineering education research by demonstrating that self-efficacy and goal orientation shaped engineering problem-solving behavior.

Instructional design should intentionally align problem complexity with students' motivational profiles and provide scaffolds that help performance-oriented students tolerate ambiguity without disengaging. To sustain through problem-solving successfully, instruction should therefore aim to cultivate conceptually grounded self-efficacy by emphasizing understanding of underlying principles, encouraging explanation-based reasoning, and validating effortful sense-making rather than speed or correctness alone.

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