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RESEARCH ARTICLE

The Concept of Logical Thinking and Its Role in The Problem-Solving Process

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Abstract

Logical thinking is commonly treated as a set of formal operations (analysis, inference, justification) and, at the same time, as a culturally mediated cognitive practice shaped by education, language, and domain experience. This article examines logical thinking as a functional system that supports problem solving by stabilizing reasoning under uncertainty, constraining intuitive responses, and enabling reliable verification of solutions. Using an integrative literature-based method (conceptual synthesis of cognitive psychology, educational theory, and problem-solving research), the study proposes a process model in which logical thinking contributes at each stage of problem solving: constructing a representation, selecting a strategy, executing inference, and validating outcomes. The results clarify how logical operations interact with heuristics, working memory, and metacognition, and why logical competence is not reducible to "knowing rules" but requires transfer-sensitive practice and reflective control. The discussion highlights instructional implications for developing learners' reasoning: explicit argumentation routines, structured problem representation, and feedback that targets inferential steps rather than final answers. The conclusion argues that logical thinking functions as a quality-control mechanism in problem solving, improving accuracy, explainability, and transfer across tasks.

KEYWORDS

Logical thinking; reasoning; problem solving; inference; metacognition; heuristics; cognitive load; education.

INTRODUCTION

Problem solving is one of the most frequently cited goals of contemporary education and professional training, yet it remains an unevenly developed competence across learners and contexts. Some individuals generate solutions quickly, while others struggle even when they possess relevant knowledge. This discrepancy is often attributed to differences in prior experience, motivation, or general intelligence; however, research in cognitive psychology and education has consistently shown that the quality of reasoning processes—how people interpret a problem, structure information, choose operations, and check conclusions—plays a decisive role in whether a solution is correct, defensible, and transferable to new situations. Within this cluster of cognitive processes, logical thinking occupies a distinctive position because it concerns the normative dimension of reasoning: the extent to which conclusions follow from premises, the consistency of steps, and the adequacy of justifications.

Logical thinking is sometimes misunderstood as a narrow "school topic" associated with formal logic or with certain types of mathematics tasks. In practice, logical thinking is more broadly relevant. It helps a physician evaluate competing diagnostic hypotheses, enables a teacher to interpret student errors and adapt instruction, and supports a manager in analyzing trade-offs under constraints. In each case, problem solving requires more than generating an answer; it requires building an argument for why the answer is warranted, anticipating counterexamples, and coordinating evidence with rules. In everyday contexts, people often rely on intuitions and heuristics, which can be efficient but also produce systematic errors. Logical thinking is therefore important not only as a source of methods, but also as a regulatory mechanism that can detect inconsistencies, reduce bias, and stabilize decision making.

Despite widespread recognition of its importance, the relationship between logical thinking and problem solving is frequently described in general terms, such as "logic improves thinking" or "logical tasks develop intellect." Such statements are directionally correct but theoretically underspecified. They do not clarify which components of logic matter most (representation, inference, verification), when logic supports performance and when it may hinder it (for example, under heavy cognitive load), or how logical competence can be developed so that it transfers beyond tasks that resemble classroom exercises. Addressing these questions requires an integrative view that connects the formal properties of logic with psychological mechanisms of reasoning and with educational conditions for learning.

This article aims to conceptualize logical thinking as a functional system within problem solving and to provide a coherent IMRAD-structured analysis of its role. The focus is not on proving a new theorem in logic, but on explaining how logical operations become usable cognitive tools, how they coordinate with heuristics and metacognition, and how they can be cultivated through instruction and practice. By clarifying these mechanisms, the article supports both theoretical understanding and practical design of learning environments that develop robust problem-solving competence.

The study uses a conceptual-analytical methodology grounded in integrative literature synthesis. The "materials" consist of foundational and contemporary sources from (a) cognitive psychology of reasoning and problem solving, (b) educational psychology and instructional design, and (c) research on critical thinking and metacognition. The selection includes classic works on heuristics and biases, dual-process theory, information processing models of problem solving, and pedagogical frameworks that emphasize reasoning as a learnable competence.

The method proceeds in three steps. First, key definitions of logical thinking and problem solving were extracted and compared to identify shared components and points of divergence, with attention to whether logic is treated as a formal system, a mental skill, or a socially mediated practice. Second, the extracted components were mapped onto process models of problem solving in order to locate where logical operations exert influence. Third, the analysis was consolidated into a process model that specifies (i) the contribution of logical thinking at each phase of problem solving and (ii) the psychological conditions under which this contribution is strengthened or weakened, such as working memory limits, cognitive load, and metacognitive control.

Because the article is conceptual rather than experimental, "results" are presented as theoretically grounded propositions and an integrative model. These results are evaluated through coherence with established findings across the literature and through explanatory adequacy for typical performance patterns in educational and applied settings (for example, common errors in reasoning, differences between novice and expert problem solvers, and the role of verification in solution accuracy).

A minimal definition of logical thinking describes the ability to draw valid conclusions from given premises and to justify those conclusions according to rules of inference. While this definition captures the normative core, it is insufficient for explaining real problem solving because it overlooks how premises are formed, which information is treated as relevant, and how inference is implemented under cognitive constraints. In problem solving, the premises are rarely presented as clean formal statements; they must be constructed from natural language, data, diagrams, or contextual cues. Therefore, logical thinking in practice includes at least three interdependent capabilities: representational structuring, inferential execution, and justificatory control.

Representational structuring refers to the transformation of an ill-structured or information-rich situation into a manageable problem representation. This includes identifying variables, constraints, goals, and relationships. A learner may "know" logical rules but still fail if the problem is encoded incorrectly. Inferential execution refers to applying transformations that preserve truth or plausibility under the problem's rules, such as deducing consequences, establishing equivalence, or eliminating contradictions. Justificatory control refers to monitoring whether steps are warranted and whether conclusions are consistent with the constraints, which includes checking for hidden assumptions, testing boundary cases, and verifying that a solution satisfies the original conditions.

This functional view implies that logical thinking is not merely a static competence but a process-oriented capacity that integrates knowledge of rules with control of reasoning. It also implies that logical thinking is situated: it depends on the domain's representational tools, conventions, and typical forms of evidence. For instance, logical thinking in algebra relies heavily on symbolic manipulation and equivalence relations, whereas in legal reasoning it relies more on argument structure, interpretation, and precedent. The underlying logic may be similar in terms of validity and consistency, but the operationalization differs.

The analysis yields a four-phase model describing where logical thinking is most critical in problem solving: representation, strategy selection, inference execution, and verification. These phases do not necessarily occur in a strict linear sequence; problem solvers often cycle between them. Nevertheless, each phase introduces specific vulnerabilities that logical thinking can address.

In the representation phase, logical thinking contributes by enforcing coherence and explicitness. A coherent representation reduces ambiguity and prevents irrelevant details from dominating attention. In a word problem, for example, students often misinterpret relational terms ("more than," "less than," "at least") and build an incorrect set of constraints. Logical thinking helps by translating language into explicit relations and by checking whether the relations can jointly hold without contradiction. When learners are trained to express constraints formally or semi-formally, they are less likely to proceed on the basis of vague impressions.

In the strategy selection phase, logical thinking functions as a rational constraint on possible actions. Many errors arise not because a chosen strategy is executed incorrectly but because it is unjustified for the problem type. Logical thinking supports selection by requiring a reason for why a method should work. In mathematical problem solving, this can mean recognizing whether the problem calls for an invariant, a proof by contradiction, or a constructive procedure. In scientific reasoning, it can mean deciding whether a hypothesis can be tested via controlled comparison or requires modeling. Logical thinking thus reduces "method blindness," in which learners apply familiar procedures regardless of fit.

In the inference execution phase, logical thinking provides the operational core. Here the solver performs transformations that should preserve the relevant properties of the problem. The quality of inference depends on both accuracy and stability under load. Working memory limitations often lead to skipped steps, implicit assumptions, or premature conclusions. Logical thinking reduces these risks by promoting stepwise reasoning and by maintaining the connection between each step and the problem constraints. Importantly, effective inference execution is rarely purely formal; it includes the integration of domain knowledge. For example, in clinical problem solving, a physician's inferences draw on causal models of physiology and on probabilistic reasoning about symptom patterns. Logical thinking does not replace domain knowledge but structures its use.

In the verification phase, logical thinking acts as a quality-control mechanism. Even skilled problem solvers can reach an incorrect answer through a subtle misstep or a misread condition. Verification is therefore not a decorative final check; it is an essential component that can detect errors and improve transfer. Verification includes substituting the solution back into the original constraints, testing limiting cases, looking for alternative derivations that converge on the same result, and evaluating whether the result is plausible given the context. Logical thinking strengthens verification by treating it as a requirement for acceptability, not merely as an optional habit.

Problem solving frequently begins with intuitive pattern recognition. People see a structure that resembles a familiar template and generate a candidate solution rapidly. This mechanism is efficient and often necessary, especially in time-pressured environments. However, intuition can mislead when superficial features trigger inappropriate analogies or when cognitive biases distort judgment. The literature on heuristics and biases shows that individuals systematically deviate from normative reasoning under certain conditions, such as when probabilities are expressed in abstract terms, when framing effects alter perceived value, or when representativeness substitutes for statistical inference.

Logical thinking moderates these vulnerabilities by providing a deliberate control layer. In dual-process terms, intuitive processing generates candidates quickly, while analytic processing evaluates and corrects them. The key point is not that intuition is "bad" and logic is "good," but that reliable problem solving requires coordination. Logical thinking is particularly valuable when the problem is novel, when stakes are high, or when consequences are hard to reverse. Under such conditions, the cost of a reasoning error exceeds the cost of slower processing.

The analysis suggests that logical thinking contributes to coordination by (a) making assumptions explicit, (b) imposing consistency constraints, and (c) requiring evidence-justified transitions between steps. These functions do not eliminate heuristics; instead, they determine when heuristics can be trusted and when they must be overridden. In educational settings, this coordination is visible when students learn to pause after an initial guess and reconstruct a solution path that can be defended. Over time, well-practiced logical routines can become partially automatized, thereby reducing the perceived conflict between speed and rigor.

A common obstacle in teaching logical thinking is the mismatch between formal idealization and cognitive reality. Formal proofs can be long, and complex problems can overwhelm learners' working memory. Cognitive load theory distinguishes intrinsic load (complexity inherent in the task), extraneous load (load imposed by poor design), and germane load (load devoted to learning). Logical reasoning is vulnerable when extraneous load is high, for example when instructions are ambiguous, representations are cluttered, or learners must coordinate multiple notations without support. Under such conditions, learners may abandon logical steps and rely on guessing or rote procedures.

The model therefore treats logical thinking as dependent on representational supports that reduce extraneous load. Examples include clear symbolic notation, well-designed diagrams, and structured writing of reasoning steps. Importantly, supports should not replace reasoning; they should offload irrelevant burdens so that the learner can focus on inferential structure. As learners gain expertise, they can handle more intrinsic complexity because schemas stored in long-term memory reduce working memory demands. This aligns with research on expertise: experts do not reason "harder" in every moment; they often reason more efficiently because they have organized knowledge structures that guide attention and reduce search.

In this light, developing logical thinking requires not only teaching rules but also designing practice that builds schemas for common problem structures. When learners repeatedly solve problems that share deep structure, they become able to recognize the relevant relations quickly and to allocate cognitive resources to verification and refinement rather than to basic decoding.

The results support a view of logical thinking as both a normative and a psychological phenomenon. Normatively, logic defines standards of valid inference and consistency. Psychologically, logical thinking is realized through representational choices, controlled attention, and metacognitive monitoring. This dual character explains why logical competence is often uneven: a learner may know certain formal rules but fail to apply them because the problem representation is unstable, because working memory is overloaded, or because the learner lacks the habit of verification. Conversely, a learner may show reasonable problem-solving success through intuitive and domain-based heuristics but struggle to justify solutions or to transfer them to new contexts because inferential control is underdeveloped.

The process model clarifies several persistent educational challenges. One challenge is "answer-centered" instruction, where success is measured primarily by the final output. Such environments encourage learners to treat reasoning as a hidden process and to focus on shortcut methods. The model implies that instruction should instead make reasoning visible and assessable by attending to the representational and inferential steps. This approach aligns with traditions of mathematical proof, scientific argumentation, and writing-to-learn, in which the quality of the argument matters at least as much as the conclusion.

Another challenge is the limited transfer of logical skills. Students may learn to solve certain textbook logic puzzles but fail to apply similar reasoning in everyday decisions or in other subjects. The analysis suggests that transfer is constrained by representation and context cues. If learners treat logical thinking as a domain-specific ritual, they will not recognize opportunities to apply it elsewhere. Transfer improves when learners practice logical routines across varied contexts and when instruction explicitly links reasoning patterns to multiple domains. For example, the same structure of "if-then" reasoning and counterexample testing can be practiced in language argumentation, scientific hypothesis testing, and mathematical proof, thereby strengthening the abstract schema.

A third challenge is the tension between rigor and engagement. Some learners perceive logical reasoning as tedious or purely formal. This perception often arises when tasks are disconnected from meaningful goals or when instruction emphasizes rules without demonstrating their functional value. The model provides a constructive alternative: logical thinking can be framed as a tool for controlling uncertainty, improving reliability, and reducing error. When learners see that verification prevents mistakes and that explicit reasoning enables communication and collaboration, logic becomes an instrument rather than an obstacle.

From a cognitive perspective, metacognition is the bridge between knowing logical rules and using them strategically. Metacognitive monitoring includes recognizing confusion, detecting contradictions, and deciding when to slow down and check steps. Metacognitive control includes selecting strategies, allocating time, and revising representations. Logical thinking is strengthened when learners develop metacognitive routines that trigger verification and justification, particularly after an intuitive answer is generated. This supports a pragmatic view: logical thinking is not only about producing correct answers but also about managing one's own reasoning process.

The implications extend to assessment. Traditional tests may underestimate logical thinking if they emphasize speed and final answers. Assessments that capture reasoning steps, explanations, and error analysis provide a more valid measure. Such assessments can also support learning by identifying where the reasoning chain breaks: at representation, strategy selection, inference execution, or verification. In this sense, logical thinking can be operationalized for pedagogy as a set of observable practices, such as articulating constraints, stating assumptions, providing warranted transitions, and checking solutions against conditions.

Finally, the analysis suggests a balanced relationship between logic and intuition. High-level problem solving often begins with intuitive insight, especially among experts, but expertise also includes disciplined verification. The most reliable performance comes from a dynamic interplay: intuition proposes, logic disposes. Education that cultivates only one side produces either rigid formalism without adaptability or flexible guessing without accountability. A mature problem solver integrates both, using logical thinking to structure, test, and communicate solutions.

Logical thinking plays a central role in problem solving because it organizes representation, constrains strategy selection, stabilizes inference execution, and provides a systematic basis for verification. Its contribution is not limited to formal correctness; it also improves explainability, reduces bias, and supports transfer across domains. The study's integrative model shows that logical thinking is best understood as a functional system rather than as a list of rules: it depends on representational structuring, inferential operations, and metacognitive control under cognitive constraints. Educationally, developing logical thinking requires practice that makes reasoning visible, reduces extraneous cognitive load, and targets verification and justification as core components of successful problem solving. When cultivated in this way, logical thinking becomes a practical quality-control mechanism that enhances the reliability and adaptability of human reasoning in academic, professional, and everyday contexts.

References

1. Пойа Д. Как решать задачу: новое понимание математического метода / пер. с англ. М.: Наука, 1975. 224 с.
2. Dewey J. How We Think. Boston: D. C. Heath and Company, 1910. 300 p.
3. Newell A., Simon H. A. Human Problem Solving. Englewood Cliffs: Prentice-Hall, 1972. 920 p.
4. Kahneman D. Thinking, Fast and Slow. New York: Farrar, Straus and Giroux, 2011. 499 p.
5. Tversky A., Kahneman D. Judgment under uncertainty: Heuristics and biases // Science. 1974. Vol. 185, no. 4157. P. 1124–1131.
6. Stanovich K. E. Rationality and the Reflective Mind. New York: Oxford University Press, 2011. 336 p.
7. Evans J. St. B. T., Stanovich K. E. Dual-process theories of higher cognition: Advancing the debate // Perspectives on Psychological Science. 2013. Vol. 8, no. 3. P. 223–241.
8. Sweller J. Cognitive load during problem solving: Effects on learning // Cognitive Science. 1988. Vol. 12, no. 2. P. 257–285.
9. Sweller J., van Merriënboer J. J. G., Paas F. G. W. C. Cognitive architecture and instructional design // Educational Psychology Review. 1998. Vol. 10, no. 3. P. 251–296.

10. Vygotsky L. S. Mind in Society: The Development of Higher Psychological Processes. Cambridge, MA: Harvard University Press, 1978. 159 p.

11. Piaget J. The Psychology of Intelligence. London: Routledge, 1950. 182 p.

12. Bransford J. D., Brown A. L., Cocking R. R. (eds.) How People Learn: Brain, Mind, Experience, and School. Washington, DC: National Academy Press, 2000. 374 p.

13. Schoenfeld A. H. Mathematical Problem Solving. Orlando: Academic Press, 1985. 409 p.

14. Chi M. T. H., Glaser R. Problem solving ability // Sternberg R. J. (ed.) Human Abilities: An Information-Processing Approach. San Francisco: W. H. Freeman, 1985. P. 227–257.

15. Ericsson K. A., Kintsch W. Long-term working memory // Psychological Review. 1995. Vol. 102, no. 2. P. 211–245.