European Journal of Social Sciences Studies
ISSN: 2501-8590
ISSN-L: 2501-8590
Available on-line at: www.oapub.org/soc

DOI: 10.46827/ejsss.v12i2.2188 Volume 12 | Issue 2 | 2026

LOGIC AND LANGUAGE IN COGNITIVE PROCESSES AND THEIR APPLICATIONS IN EDUCATION

Trinh Thu Huong[1],
Nguyen Anh Thuong[2i]
[1]Saigon University,
Vietnam
[2]University of Social Sciences and Humanities,
VNU-HCM,
Vietnam

Abstract:
The article examines the dialectical relationship between logic and language in the cognitive process, thereby proposing an applied model in education. Based on the analysis of logic's role as the "skeleton" and language as the "flesh" of thought, the paper indicates that optimal cognition is achieved only through a harmonious combination of these two elements. By examining the micro-interactions between logical units (concepts, judgments, inferences) and linguistic units (words, sentences, discourses), the article proposes an integrated educational model to simultaneously develop logical thinking and language proficiency. Specific applications are analyzed in teaching formal logic, developing critical thinking, and applying the TRIZ systematic innovation methodology in an educational environment.

Keywords: logic, linguistics, epistemology, education, critical thinking, TRIZ, dialectics, interdisciplinary integration

1. Introduction

In the history of philosophy and science, the relationship between logic and language has always been a central issue attracting the attention of scholars. From Aristotle's conception of logic as the "organon" (instrument) of thought, to contemporary debates on the worldview-constructing role of language, a fundamental truth is affirmed: logic and language are two inseparable aspects of the cognitive process. Logic provides the structural framework for thought, while language provides the means to express and materialize those structures.

In the context of modern education, a notable paradox exists: the separation between logical thinking training and language proficiency development. Educational

[i] Correspondence: email trunghieutr252@gmail.com

programs often treat logic as an independent subject, isolated from the language teaching-learning process. Consequently, learners may master formal logical rules but fail to apply them in expression and argumentation; conversely, individuals with rich linguistic capabilities sometimes lack rigor and system in their reasoning. This reality poses an urgent need to study the intrinsic connection between the two fields and seek an integrated model in education.

Stemming from this requirement, the article establishes three main objectives:

1) To analyze the dialectical relationship between logic and language in the cognitive process;
2) To point out the micro-interactions between logical units and linguistic units;
3) To propose a model for applying research findings into educational practice, aiming to simultaneously develop learners' logical thinking and language proficiency.

2. Literature Review

2.1. Logic: The Structural System of Thought

Logic, as the science of the laws and forms of precise thinking, acts as the "*operating system*" for cognitive activity. Logicians from Aristotle to Frege and Russell have demonstrated that thought operates according to modelable structures. These fundamental structures include: concepts (the basic units reflecting the essential attributes of objects and phenomena); judgments/propositions (the connection of concepts to affirm or deny an attribute); and inferences/reasoning (the process of drawing new judgments from existing ones). According to Hurley (2015), formal logic provides "*the tool to distinguish between good and bad reasoning*" (p. 3), helping to avoid fallacies and reach reliable conclusions. However, these abstract structures require a material medium to be actualized.

2.2. Language: The Medium for Materializing and Shaping Thought

Language, as the specific sign system of human beings, serves as the "*material shell*" of thought. Marx and Engels in The German Ideology asserted that "*language is the immediate actuality of thought*" (Marx & Engels, 1990, p. 25). Vygotsky's (1986) theory goes further by emphasizing that language is the tool for creating thought; the development of higher cognitive functions occurs through the acquisition and use of socio-linguistic tools (Vygotsky, 1986, p. 218).

Linguistic structure includes: vocabulary/lexicon (a system of signs denoting concepts); syntax (rules for combining words into sentences); semantics (the relationship between signs and meanings); and pragmatics (the use of language in specific contexts). The linguistic relativity hypothesis (Sapir, 1929) supports the view that linguistic structure influences cognition and the categorization of the world. Wittgenstein's (1953) "*language games*" approach elucidates that the meaning and logic of an utterance can only be fully understood within its specific context of use. Thus, language not only reflects but also actively participates in shaping and constructing thought.

2.3. Dialectical Relationship: The Unity in Difference of Logic and Language

The relationship between logic and language is not merely unidirectional but dialectical and reciprocal. Logic provides the structure for language, while language provides the means of expression and the condition for logic's operation. This unity can be illustrated by the photographic negative-positive principle as an analogy for the unity of opposites: Logic (the negative – akin to the film in a mechanical camera) is internal, latent, invisible, the "*hardware*" of thought; Language (the positive – akin to the developed image) is external, explicit, visible, the "*software*" of thought. These two aspects unite and transform into one another in cognition: logic cannot exist if it is not expressed, verified, and honed through language; language cannot perform its cognitive function effectively without adhering to logical laws. This theoretical foundation guides the analysis of their micro-interactions.

3. Material and Methods

3.1. Theoretical Research Methods (Primary Focus)

3.1.1 Theoretical Analysis and Synthesis

Examining philosophical, logical, and linguistic texts to clarify the dialectical relationship between logic and language.

3.1.2 Modeling Method

Constructing diagrams of the cognitive process, from the perceptual to the rational stage, and demonstrating how language acts as the "material shell" of thought in each stage.

3.1.3 Historical-Logical Method

Reviewing the development of language and logical thinking through human developmental stages to deduce general cognitive laws.

3.2. Applied Research Methods (In Education)

3.2.1 Content Analysis

Reviewing current textbook curricula or teaching methods to assess whether the logic and language usage are optimized for learners.

3.2.2 Pedagogical Observation

Monitoring how students utilize language to solve logical problems or construct arguments to identify cognitive barriers.

3.2.3 Expert Method

Interviewing or consulting educators and psychologists on integrating logical thinking training through language development.

4. Research Results

4.1. Micro-interactions Between Logical and Linguistic Units

4.1.1. Concepts and Words: The Foundational Bond

The concept is the basic unit of logical thought; the word is the basic unit of language. Their relationship is complex and multidimensional. A concept can be expressed by various words (e.g., "death" – "pass away", "sacrifice", "demise"), each carrying a distinct nuance. Conversely, a single word can denote multiple concepts (polysemy). In education, training the ability to translate between concepts and words is crucial for developing precise thinking. Exercises on defining concepts, distinguishing synonyms/antonyms, and identifying polysemy are not just linguistic tasks but also significant logical thinking exercises.

4.1.2. Judgments and Sentences: The Structure of Truth

Logical judgments find their natural expression in linguistic sentences. The structure of a judgment (subject - copula - predicate) corresponds to the sentence structure (subject - predicate). However, this correspondence is not always perfect. A sentence can express multiple judgments (ambiguity), and a single judgment can be expressed through various sentence structures (e.g., "*Everyone will die*" can be phrased as "*No one is immortal*", "All men are mortal"...). Teaching students to convert between sentence structures to express the same meaning not only enriches their vocabulary but also hones their ability to identify the logical structures hidden behind linguistic forms.

4.1.3. Inferences and Discourse: The Flow of Reason

Complex logical inferences (syllogism, induction, analogy) are expressed through discourse—a logically connected sequence of sentences. Logical connectives ("because", "therefore", "however") serve as indicators of the relationships between sentences. The ability to construct coherent discourse reflects logical thinking capabilities. Conversely, analyzing discourse to uncover hidden logical structures is a critical skill in critical thinking. In education, teaching essay writing, argument construction, and argumentative text analysis is not merely teaching language skills but also teaching logical thinking through language.

4.1.4. Logical Fallacies and Linguistic Errors: Two Sides of the Same Coin

Many logical errors manifest through specific linguistic phenomena. For example: the ad hominem fallacy is expressed through derogatory language and insults instead of debating the content; the ad verecundiam fallacy (appeal to authority) is expressed through the misuse of titles and academic degrees to create false credibility; circular reasoning (petitio principii) is expressed through the use of synonymous terms to disguise the repetition of a premise. Teaching students to identify and critique logical fallacies through linguistic analysis is an effective method for simultaneously developing language proficiency and critical thinking.

4.2. Applications in Education: An Integrated Logic and Language Model

4.2.1. Teaching Logic Through Language

Instead of teaching logic as an abstract, isolated subject, logic instruction can be integrated into the language teaching process: text logic analysis (guiding students to analyze the argumentative structure in essays, articles, speeches); paraphrasing expressions (requiring students to express the same idea using different sentence structures, recognizing the common logical core); identifying and correcting logical errors (analyzing errors in students' writing and speaking, pointing out the connection between logical fallacies and phrasing errors). This method makes learning logic more dynamic and practical while improving the quality of language use.

4.2.2. Developing Critical Thinking Through Linguistic Practice

Critical thinking—the ability to analyze, evaluate, and improve thought (Paul & Elder, 2006)—is effectively developed through linguistic activities: structured debates (organizing debates with clear rules, requiring logical arguments, factual evidence, and counter-argumentation); critical writing (guiding the writing of rebuttals against a viewpoint, analyzing the strengths/weaknesses of opposing arguments, constructing alternative arguments); fallacy analysis (providing examples of fallacies in media, advertising, politics, and guiding their analysis and critique). These activities cultivate comprehensive language skills (speaking, writing, listening, reading) alongside logical thinking, analytical, and critical abilities.

4.2.3. Applying the TRIZ Methodology in Language Education

TRIZ (Theory of Inventive Problem Solving)—the systematic innovation methodology by Genrikh Altshuller (Altshuller, 1999)—can be effectively applied in language education to resolve contradictions in expression and thought:

- **Resolving contradictions using TRIZ principles:** Guiding the identification and resolution of contradictions. For instance, the contradiction between the brevity and completeness of a summary can be resolved using the Principle of Separation (creating two versions—an ultra-short "core" version and a detailed expanded version) or the Principle of Combination (using annotated abbreviations, tables, and mind maps to pack multiple layers of information).
- **Inventing new words and expressions:** Encouraging creativity based on the principle of multifunctionality. For example, creating neologisms or idioms to describe complex concepts (like "FOMO" to describe the fear of missing out).
- **Developing systems thinking in writing:** Guiding students to view an essay as a system, adjusting a single part to improve the whole.

For feasibility, simplified instructional materials aligning creative principles with linguistic-literary contexts are needed, alongside teacher training via an interdisciplinary approach. This develops linguistic creativity and fosters systems thinking for scientific problem-solving.

4.2.4. Proposed Framework for an Integrated Educational Curriculum

To actualize the integrated model, specific learning modules must be designed and embedded into literature or social science curricula. For example, a "Argumentation and Discourse" module framework for High School:

- **Objective:** Students can analyze the logical structure of persuasive discourse and produce argumentative texts with rigorous reasoning.
- **Integrated content:** Logical concepts (judgments, deductive/inductive reasoning, fallacies); linguistic units (complex sentences, logical connectives, deductive/inductive paragraph types, argumentative texts).
- **Learning activities:** Analyzing argumentative structures in editorials/speeches; practicing writing paragraph types with different logical structures for the same thesis; "Fallacy Hunt" game (identifying and correcting logical errors in advertisements and social media); structured debates (e.g., Karl Popper format).
- **Assessment:** A short essay evaluated on logical argumentation (50%) and linguistic expression effectiveness (50%).

This model requires close collaboration between literature teachers and educators with expertise in logic/critical thinking, supported by integrated teaching materials.

5. Recommendations

5.1 Recommendations on Content and Curriculum:

- **Integrate Logic into Language: Teaching** content must not solely focus on isolated grammar or vocabulary but must embed logical laws (such as the law of identity, the law of non-contradiction, the law of excluded middle) into text analysis and creation.
- **Design Case Studies:** It is recommended to introduce exercise formats requiring learners to use language to solve logical problems, facilitating the transition of knowledge from perceptual cognition to sharp rational thought.

5.2 Recommendations on Teaching Methods:

- **Inquiry-based Learning:** Instructors should pose open-ended questions, compelling learners to use precise linguistic systems to argue, thereby refining their logical thinking structures.
- **Emphasize Terminological Precision:** In education, standardizing scientific language is a prerequisite for forming correct thought. Educational institutions are recommended to focus on defining and using terminology consistently in textbooks.

5.3 Recommendations for the Teaching Staff:

- **Foster Thinking Competence:** Teachers are not merely transmitters of specialized knowledge; they need in-depth training in general logic and psycholinguistics. This helps them understand students' cognitive processes to adjust pedagogical methods accordingly.

- **Critical Skills:** Encourage teachers to create a healthy debate environment where language is the tool to critique logical premises, helping students form independent thinking.

5.4 Recommendations on Educational Environment and Policies

- **Build a Culture of Reading and Writing:** Educational administrators are recommended to promote creative writing and deep reading activities, as these are two pivotal activities that perfect the relationship between the "shell" of language and the "core" of thought.
- **Technology Application:** Utilize Mind-map software or AI tools to help learners visualize the logical structure of language during the process of knowledge acquisition.

6. Conclusion

Logic and language are two inseparable aspects of the cognitive process. Logic provides the structure for thought; language provides the means to materialize and shape thought. This dialectical relationship manifests through micro-interactions between logical units (concepts, judgments, inferences) and linguistic units (words, sentences, discourses).

In education, the separation between teaching logic and developing language is a deficiency that must be addressed. Instead, an integrated educational model should be established, where the teaching and learning of logic are conducted through language, and language development is built upon the foundation of logical thinking. Specific applications include: teaching logic through text analysis and construction; developing critical thinking through debate and critical writing; applying the TRIZ methodology concretely and creatively to develop systems thinking and solve expressive problems; and designing highly feasible integrated curriculum modules.

Implementing an integrated educational model of logic and language not only enhances educational quality but also contributes to cultivating citizens capable of independent thinking, creativity, expression, debate, and effective persuasion—essential qualities in a knowledge-based and democratic society.

Conflict of Interest Statement
The authors declare no conflicts of interest.

About the Author(s)
Trinh Thu Huong (PhD) is an expert in the field of linguistics. Her research works include: "The preposition in in English idioms (compared to Vietnamese)"; the book "Lexicography and Encyclopedia"; the "English - Vietnamese Idiom Dictionary", etc.
Nguyen Anh Thuong holds a PhD in Philosophy and is currently a lecturer at the University of Social Sciences and Humanities. He conducts research in philosophy, religion, and logic study. Published works: The Alienated Human; Jiddu Krishnamurti's Method of Psychological Perception, etc.

References

Altshuller, G. S. (1999). *The innovation algorithm: TRIZ, systematic innovation and technical creativity.* Technical Innovation Center, Inc. Retrieved from https://books.google.ro/books/about/The_Innovation_Algorithm.html?id=T0Kk0XBH5KgC&redir_esc=y

Hurley, P. J. (2015). *A concise introduction to logic (12th ed.).* Cengage Learning. Retrieved from https://books.google.ro/books/about/A_Concise_Introduction_to_Logic.html?id=6PNuCgAAQBAJ&redir_esc=y

Marx, K., & Engels, F. (1990). *Die deutsche Ideologie*. In Karl Marx, Friedrich Engels. *Werke* (Bd. 3, 9. Auflage, S. 9–530). Dietz Verlag. (Original work published 1845–1846). Retrieved from https://www.marxists.org/archive/marx/works/download/Marx_The_German_Ideology.pdf

Nguyễn, A. T. (2021). *Logic học: Lý thuyết và ứng dụng*. NXB Đại học Quốc gia TP.HCM.

Paul, R., & Elder, L. (2006). Critical thinking: The nature of critical and creative thought. *Journal of Developmental Education, 30*(2), 34–35. Retrieved from https://www.proquest.com/docview/228409035?sourcetype=Scholarly%20Journals

Sapir, E. (1929). The status of linguistics as a science. *Language, 5*(4), 207–214. Retrieved from https://doi.org/10.2307/409588

Vygotsky, L. S. (1986). *Thought and language* (A. Kozulin, Ed. & Rev.). MIT Press. (Original work published 1934). Retrieved from https://img3.reoveme.com/m/bac6393f496a1d08.pdf

Wittgenstein, L. (1953). *Philosophical investigations*. Blackwell Publishing. Retrieved from https://static1.squarespace.com/static/54889e73e4b0a2c1f9891289/t/564b61a4e4b04eca59c4d232/1447780772744/Ludwig.Wittgenstein.-.Philosophical.Investigations.pdf