

# Investigation on the Integration of Higher Education Logic Instruction and Cognitive Development

Yuanyuan Li

*Guizhou Police College, Guiyang, Guizhou, China*

**Abstract:** In the realm of higher education, the instruction of logic plays a crucial role in cultivating the intellectual prowess and analytical acumen of college students. However, the conventional teaching methods often lean towards a theoretical approach, which proves to be challenging in effectively achieving the desired outcomes. In light of this, this research endeavors to address this issue by proposing an outcome-based education (OBE) framework for logic instruction targeted at undergraduate students from non-philosophy disciplines and postgraduate students from non-logic fields. This innovative approach encompasses the utilization of case-based teaching methodologies, fostering subjective initiative, and transforming the assessment methods. The primary objective of this study is to bridge the gap between abstract logical knowledge and the practical application of logical thinking abilities among college students, enabling them to adapt seamlessly to the future demands of both academia and the professional world. Emphasizing the significance of logic instruction in higher education, this research places particular emphasis on nurturing students' logical thinking capabilities that are relevant to their respective disciplines. By doing so, it aims to elevate their cognitive aptitude and enhance their overall capacity for learning.

**Keywords:** Logic Pedagogy; Cognitive Cultivation; Case-based Teaching Methodology; Subjective Initiative; Assessment Approach

## 1. Introduction

The process of thinking involves the generalized and indirectly reflected cognition of phenomena within the human mind. Rooted

in human perception, thinking goes beyond the limits of perception, necessitating linguistic expression for comprehension; otherwise, it remains abstract and inscrutable. [1] Thinking encompasses all cognitive and intellectual activities, delving into the intrinsic attributes, internal connections, and regularities of phenomena. It represents an advanced stage of the cognitive process and a distinctive trait setting humans apart from animals. The modernization of logic is defined by the surge and evolution of thinking theory research, which emerged as a consequence of the evolution of logical instruction. The emphasis on fostering the thinking abilities of college students is an initial outcome of the reform in logic instruction. [2] Furthering logic instruction in higher education necessitates exploration into the cultivation of rational thinking among students. The amalgamation of logic instruction and cognitive development in higher education represents a potent avenue for achieving this outcome.

## 2. Background of Logic Instruction in Higher Education

Logic instruction is a relatively recent addition to the curriculum in Chinese colleges. Only a few institutions introduce basic logic or thinking courses prior to college education. By introducing fundamental knowledge, theories, and methods of logic, logic instruction reveals the intrinsic attributes, internal connections, and developmental patterns of phenomena. Through this process, students are encouraged to improve their self-awareness, accuracy, and sensitivity to their surroundings, ultimately enhancing their ability to reason and argue. [3] Logic instruction is universally recognized as an indispensable course for cultivating students' thinking abilities, particularly at the college level. Both everyday thinking and professional cognition require the application of proper thinking methods, even more so for

individuals engaged in specialized fields. Logic instruction in Chinese colleges should also adapt to the development of the era and cultivate students' thinking abilities. Enhancing students' thinking capacity should be regarded as the ultimate goal of logic instruction, as it holds a distinct role that other disciplines cannot easily replace in fostering and improving students' thinking abilities. [4] When teachers establish this educational objective, their focus shifts away from monotonously imparting logical knowledge towards inspiring students' proactive exploration, aligned with the requirements of their disciplines. By continuously reinforcing the training of rational thinking, teachers veer away from the traditional approach of accepting things at face value and replicating others' methods, thus cultivating habits of inquiry into "why" and "how to excel". This shift in pedagogy is crucial for enhancing students' thinking capabilities and elevating their overall quality.

### 3. The Cognitive Capacities of College Students

In the 1980s, Qian Xuesen began to focus on cognitive research, asserting that thinking is a sophisticated cognitive activity inherent to human beings. It involves a series of intricate movements within the human brain, combining originally stored knowledge and experiences with continuously input new information. [5] Thinking can be categorized into visual thinking, abstract thinking, and inspirational thinking. Such classifications bear no hierarchy of superiority or inferiority, as each type of thinking offers unique functionality to individuals. [6] Piaget pointed out that young people can break free from specific levels of thought through cognitive training. However, due to the differing circumstances of each individual, some youths drop out before completing their education, missing the opportunity during the most precious stage of their lives to advance their thinking. This underscores the crucial stage of cognitive development during one's youth.

Higher education should conform to the laws of cognitive development, enabling college students to possess the abilities of logical reasoning and mastery of complex abstract concepts. Only through such training can their thinking abilities be nurtured. If colleges

engage in mechanical teaching methods, students will not fully comprehend principles and concepts; their engagement with events and experiments will be merely passive observation, devoid of personal exploration and discovery. Such teaching methods do not substantially enhance thinking abilities. It is important to connect the characteristics, specific levels, and distinctive objects and events of cognitive development during the college years, and establish valuable learning objectives. This is the key to helping students transcend their current level of thinking and improve their capacity for accurate reasoning. In today's complex social environment, knowledge and information inundate our daily lives. While college students enjoy the conveniences brought by information, they gradually lose themselves amidst the overwhelming volume of information. They either face an enormous amount of information, struggling to discern and find relevant content, lacking the ability to search for the information they need, and thus end up conforming to popular opinion and losing their individuality; or they confine themselves within an information cocoon woven by big data, persistently browsing information that aligns with their own interests, remaining isolated in their own narrow perspectives, becoming increasingly distant from the external world and their surroundings. Therefore, it is only when teachers lay a solid foundation through teaching that they can develop students' thinking abilities and help them avoid the aforementioned scenarios. Hence, in higher education, particularly in logic instruction, simply imparting theoretical knowledge or conducting experiments is insufficient to cultivate students' logical thinking skills.

### 4. Integration of Logic Instruction and Cognitive Development in Higher Education

#### 4.1 Designing a Logic Curriculum Framework

Considering the current landscape in China, assuming that higher education institutions possess the necessary resources, it would be feasible to introduce two distinct courses, namely *Logic* and *Cognitive Science*. The course in *Logic* would be dedicated to

transmitting fundamental principles of reasoning, while *Cognitive Science* would be responsible for honing everyday thinking skills. Alternatively, in the absence of specific teaching requirements, the fusion of *Logic* and *Cognitive Science* could effectively integrate logic education with cognitive training in order to maximize the impact of the combined curriculum.

Depending on the focus of the institution, higher education institutions should clearly distinguish the functions of different types of logic education. Professor Zhang Jianjun from Nanjing University, in his paper *Several Insights on Realizing the Modernization of Logic Instruction*, extensively elaborates on four levels of logic education: logic education for graduate students majoring in logic, logic instruction for undergraduate philosophy majors, logic instruction for undergraduate non-philosophy majors and non-logic graduate students, and logic education in the basic national education system. [1] The demands on cognition differ significantly between research-oriented and application-oriented talents. Correspondingly, their methods of cognitive training also vary substantially. Therefore, the design of logical education should be tailored to the specific circumstances of the school, field of study, and educational environment.

According to the diverse nature of academic disciplines within higher education, each field places varying emphasis on cognitive training in logical education. For instance, the discipline of economics should prioritize mathematical logic instruction, enabling students to enhance their computational, statistical, and reasoning capabilities within the context of their studies. In the domain of education, the focus should lean towards traditional logic education, empowering students to cultivate the ability to reiterate knowledge and construct knowledge maps as they engage in the study of concepts and judgments. Similarly, the field of law should emphasize formal logic instruction, training students to master the skills of evidence presentation, cross-examination, and refutation as they delve into the realms of reasoning and argumentation. Following the identification of logical education focal points corresponding to specific disciplines, the subsequent execution of these should center on cognitive training.

The mere impartation of theoretical knowledge, particularly abstract theoretical knowledge, without a focus on the cultivation of students' cognitive abilities, proves to be ineffective. [7] Within the educational realm, teachers are advised to refrain from imparting abstract theories that are indirectly related to or insignificantly impact real-world problem-solving. Instead, the common and practical aspects of logical knowledge should be transformed and integrated into everyday cognitive training, with a deliberate emphasis on fostering students' abilities in argumentation and reasoning.

The design of a logical education curriculum is contingent upon the specificities of the respective disciplines; only then can the abstract theoretical knowledge of logic gradually transform into the cognitive prowess of college students. [8] Through continual training, logical theories take root within the hearts of college students, ultimately manifesting as various forms of thinking, which, in conjunction with specialized knowledge, coalesce into the rational thinking processes within the minds of students as they engage in their daily learning experiences. These cognitive faculties will eventually accompany students as they navigate their transition into the professional world, marking the path towards maturity. [9] This progression epitomizes the transformation of logical education within higher education institutions—from theory to practice, and from knowledge acquisition to the development of cognitive abilities.

## 4.2 Reformation of Current Teaching Methods

The ultimate objective of logic instruction at the college level is to provide effective training for students' cognitive faculties and elevate their thinking capabilities. However, the widespread adoption of logic education in China poses various challenges, primarily due to the extensive set of logical rules and the intricate nature of its symbols, which embody highly abstract principles. [10] Consequently, both teachers and students often struggle during the instructional process, with students finding it arduous to comprehend and grasp the subject matter, even after completing their studies and assessments. This predicament necessitates the continuous exploration of

teaching methodologies and the introduction of innovative pedagogical approaches by college professors. They must endeavor to assist students in overcoming their apprehensions and reservations toward learning while acquiring a diverse range of techniques to effectively impart logical skills and proficiency.

#### 4.2.1 Utilizing the case-based teaching methodology

The case-based teaching methodology stands as a highly effective means to enhance the cognitive abilities of college students. In this approach, teachers, aligning with the instructional objectives and content requisites, select cases that are not only relevant to logical concepts but also pertain to specialized subject matter. They then organize or guide students in evaluating and investigating these cases. This process enhances students' problem awareness and engagement, ignites their learning interests, and cultivates their cognitive prowess. [11] The retelling of cases allows students to engage in imaginative thinking, encouraging them to effectively express the remarkable aspects of the cases through language, body language, facial expressions, and even micro-expressions. Analyzing cases encourages students to actively gather and analyze relevant information and data, enabling them to propose various hypotheses related to the cases and make concerted efforts to demonstrate and comprehend the theory. Engaging in direct recitations, analyses, discussions, and evaluations of cases, consolidating similar conclusions, scrutinizing and evaluating different perspectives, refining one's own viewpoints, and absorbing and applying others' insights—all resonate throughout the entire process, embedding various logical principles from start to finish. While the method entails comprehensive logical instruction, it does not impart tangible knowledge, but rather fosters the development of intangible cognitive abilities.

#### 4.2.2 Cultivating subjective initiative

Transitioning from the conventional model of teachers lecturing and students passively receiving information to a dynamic classroom environment where teachers assign tasks and students actively engage in completing them marks a significant shift. Focused on a specific logical concept, scenarios relevant to daily life or professional settings are crafted, prompting

students to deliver speeches or engage in debates, thereby honing their cognitive skills through active participation. This transformation in classroom dynamics unleashes the full potential of students' subjective initiative. Subjective initiative stands as a distinctive attribute that sets humanity apart from the animal kingdom. It is through the use of their own hands and through inventions and creations that humans have reshaped the world and themselves—a capability animals do not possess. Ultimately, this capacity is rooted in the operation of cognition. [12] The teaching of logic must not only impart knowledge of logic but also further refine this inherent human capacity. In the instructional process for college students, teachers should intentionally frame conceptual points as various problems, allowing students to tackle each one individually. Consequently, addressing these issues becomes a continuous exercise in refining cognitive prowess through problem-solving, perpetually reinforcing these skills.

### 4.3 Transforming the Assessment Approach

Aligned with the principles of OBE, assessments should gradually shift from single, end-of-semester exams to ongoing evaluations spanning the entire duration of the course. Particularly in subjects like logic, which involve numerous abstract and challenging concepts, examinations should emphasize the application of practical skills rather than solely testing rote memorization of theoretical knowledge. Teachers should establish an assessment framework that is conducive to evaluating students' cognitive abilities developed through the study of logic, with a focus on their reasoning and argumentation skills. Thus, logic courses must fully transition from knowledge-based assessments to competency-based evaluations by combining regular assessments with end-of-semester exams, ensuring comprehensive and continuous evaluation throughout the semester. Daily assessments should include attendance, class participation, note-taking, and completion of assignments, while placing a significant emphasis on classroom performance, showcasing students' ability in various given scenarios. Quantitative measures should be employed whenever possible to reflect the scores corresponding to their

demonstrated cognitive abilities. These daily scores, when combined, contribute to students' overall performance. During the final exam, subjective questions should be used primarily, with a focus on assessing students' comprehension, judgment, analysis, synthesis, reasoning, and argumentation skills in response to diverse information. Both the regular and final exam scores together form the comprehensive grades for students, ensuring that assessment is integrated throughout the teaching of logic, ultimately achieving the ultimate goal of enhancing students' cognitive abilities through logical instruction.

### 5. Conclusion on Logic Teaching and Cognitive Development in Higher Education

This study reveals several key findings regarding logic teaching in Chinese higher education. Firstly, logic instruction is typically introduced at the higher education level in China. Secondly, there is a lack of differentiation in the emphasis of logic teaching based on academic levels and disciplines within colleges. Thirdly, the primary mode of logic instruction relies heavily on theoretical explanations. Lastly, logic teaching has not been effectively integrated with the cultivation of critical thinking skills. In accordance with the principles of OBE, it is essential to reframe logic instruction to encompass the development of students' cognitive abilities. Starting from the foundation of logic teaching itself, it is crucial to integrate theoretical explanations of logic concepts with the cultivation of critical thinking skills. This integration should be tailored to the institutional positioning, educational direction, and students' majors within the college. The primary focus should be on fostering students' logical thinking abilities that align with their respective fields of study, enabling them to adapt to the learning demands necessary for their future careers in related industries or other sectors.

There are several challenges identified in the research. Firstly, there is a high demand for teachers. They are expected to possess a deep understanding of the subject matter and the specific cognitive abilities that need to be developed in their students. They should also

design and implement effective course syllabi. Secondly, there is a high expectation for students. They are required to shift from passive learning to active learning, which includes extensive preparation before class. Thirdly, there is a demand for diverse teaching methods and assessment approaches, which necessitate acquiring more teaching resources and utilizing a variety of instructional techniques in addition to conventional teaching plans. These challenges cannot be resolved within a short time frame and require a relatively extended period for gradual implementation.

The pragmatic application of logic is poised to become the prevailing trend in the future development of higher education. The ultimate realization of logical teaching objectives lies in the cultivation of critical thinking. In the context of Chinese higher education, logical instruction will increasingly prioritize the enhancement of cognitive abilities and the cultivation of critical thinking.

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