2026 World Journal of Innovation and Modern Technology, Vol. 9, Issue 10 (Oct)
ISSN 2682-5910
DOI: 10.66069/ojspub.26821004

Strategies for Cultivating Students' Critical Thinking Based on the Problem Continuum

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Abstract: ***Critical thinking is one of the core components of "learning and innovation skills" in the 21st-century learning framework and is of great significance to students' development. At present, the cultivation of critical thinking in secondary school classrooms still suffers from problems such as superficial question design, insufficient classroom follow-up questioning and argumentation, and an overemphasis on outcomes in teaching evaluation. The problem continuum theory provides theoretical guidance for addressing these problems. By adhering to the principles of contextualization, gradual progression, and student agency, teachers can adopt strategies such as delving deeply into teaching texts to identify resources for critical thinking, analyzing instructional content to design progressively sequenced problem sets, optimizing evaluation methods to attend to the entire process of thinking development, and optimizing teacher–student interaction to create an open and inclusive dialogic classroom, thereby promoting the cultivation of students' critical thinking.***

Keywords: Critical thinking, Problem continuum, Classroom questioning.

1. INTRODUCTION

Against the backdrop of rapid globalization and informatization in the 21st century, critical thinking has become a core issue in international educational reform. Shi Man and other scholars point out that the knowledge economy era requires citizens to possess critical thinking, creativity, and problem-solving abilities; these emerging competencies have begun to emerge in the field of education and have become a focus of educational reform in various countries. The Core Competencies for Chinese Students' Development states that critical thinking is a basic element of the scientific spirit among the six core competencies, and that students should possess a problem consciousness and be able to think independently and make judgments; they should think rigorously and be able to analyze problems from multiple perspectives and dialectically, and make choices and decisions. Professor Zhang Hua points out that the United States lists critical thinking as one of the core components of "learning and innovation skills" in the 21st-century learning framework, and that it is also one of the core competencies pursued worldwide, namely "collaboration, communication, critical thinking, and creativity." The English Curriculum Standards for General Senior High Schools (2017 Edition, 2020 Revision) also regards thinking quality as an important component of the core competencies of the English subject, emphasizing the cultivation of students' logical, critical, and creative thinking abilities. Professor Zhong Qiquan also remarks that critical thinking is a demand of school education in the new era and an educational strategy for systematically addressing problems caused by exam-oriented education, such as students' low basic academic ability, insufficient problem-solving ability, low self-affirmation, and low communication ability. It can thus be seen that critical thinking has become an important theme running through international educational reform and Chinese educational policy; cultivating critical thinking is both a strategic need for responding to changes of the times and an important pathway for realizing the modernization of education and remedying the drawbacks of traditional education.

2. THE CONNOTATIONS OF CRITICAL THINKING AND THE PROBLEM CONTINUUM

2.1 The Problem Continuum

The "problem continuum" theory was proposed by Professor Maker of Arizona State University in the United States. Centering on three dimensions—the structure of the problem, the method of solving the problem, and the result of the problem—it divides different instructional problems into five categories, forming a complete system. These five categories of problems constitute a continuum that gradually transitions from closed to open, and they reflect four different levels of cognition: fact, concept, generalization, and theory. As a systematic tool for problem classification and design, the problem continuum theory has now been widely applied in instructional design across various subjects, aiming to promote students' deep understanding and cultivate their innovative abilities by constructing a problem sequence that proceeds from the shallow to the deep.

The problem continuum is characterized by hierarchical progression. Using the three dimensions of problem structure, solution method, and problem result as the yardstick, the lowest level consists of factual problems. These problems are well-structured, usually have relatively fixed answers, and their problem contexts are close to students' daily experience, so most students are able to answer them. The highest level consists of theoretical problems. These problems are ill-structured, usually have no fixed approach to answering, are relatively open, and place higher demands on students, requiring teachers to provide appropriate scaffolding. The problem continuum is also characterized by subjective difference: the position of the same problem within the problem continuum changes with students' cognitive levels. The same inquiry question may also produce different instructional effects due to differences in students' foundations. Based on this characteristic, teachers can conduct differentiated questioning according to students' thinking levels, so that every student can achieve the development he or she deserves in inquiry activities.

2.2 Critical Thinking

Research on critical thinking originated with J. Dewey. In How We Think, he proposed taking reflective thinking as the aim of school education, pointing out that reflective thinking is the active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends. This is regarded as the prototype of the concept of critical thinking. The first person to propose the term "critical thinking" was the British scholar Stebbing, but she did not offer a conceptual interpretation of the term. In the 1980s, a critical thinking movement swept across North America, and research on critical thinking received widespread attention. Ennis defined it as reasonable, reflective thinking that is focused on deciding what to believe or do. This definition emphasizes the decision-making and rationality features of critical thinking. Paul distinguished between "weak critical thinking" and "strong critical thinking." The former is a combination of individual skills that may be used for self-protection and self-deception; the latter is fair-minded thinking that involves not only logical analysis of others but also reflection on one's own inherent biases. Later, in order to further study critical thinking, Facione, together with 46 scholars, launched the Delphi Project. After more than two years and a total of six rounds of joint discussion, the Delphi Report was released in 1990. This report provided a detailed explanation of the definition, teaching, and assessment of critical thinking and is a landmark work in critical thinking research. The report defines critical thinking as a purposeful, self-regulatory process of judgment and clearly points out that critical thinking includes not only cognitive skills but also affective dispositions.

2.2.1 Critical Thinking Dispositions

Critical thinking dispositions are an individual's internal thinking attitudes and spiritual orientations, embodied in an individual's consciousness of questioning and reflecting on knowledge, viewpoints, and phenomena. This consciousness is not a simple negation of everything; rather, on the basis of respecting facts and reason, it maintains appropriate skepticism toward established viewpoints and seeks more reasonable explanations through the individual's own in-depth practical investigation. Critical thinking dispositions have the following characteristics. The first is active questioning: when faced with a new viewpoint, an individual will not easily accept or blindly believe it, but will actively examine and question its rationality, validity, and reliability, identifying possible loopholes or biases by exploring the logic and supporting evidence behind the viewpoint. The second is openness and inclusiveness: although individuals with critical thinking dispositions maintain a certain skepticism toward others' viewpoints, they are also willing to listen to others' viewpoints; even if the other party's viewpoint may be diametrically opposed to their own, they will seriously consider the rationality of the other party's viewpoint. The third is self-reflection: after colliding with others' viewpoints, individuals also reflect on their own viewpoints. In this process, they carefully examine the formation process of their viewpoints, the evidence on which they are based, and the logic behind them, identify what is unreasonable, and then further collect evidence to adjust their original viewpoints.

2.2.2 Critical Thinking Skills

Tao Wei and Shen Hong point out that the part of critical thinking possessing the attribute of systematic knowledge is critical thinking skill. Pei Changgen and Fan Jiancheng believe that critical thinking skills refer to the cognitive abilities people need when engaging in critical thinking activities, including understanding, analysis, interpretation, inference, evaluation, and self-regulation. Integrating the views of various scholars, critical thinking is defined here as a series of specific methods and techniques used by individuals in the process of critical thinking to

effectively analyze and evaluate existing information; these skills are the concrete manifestation of critical thinking. Critical thinking skills include three aspects. The first is analytical ability. Analytical ability is the foundation of critical thinking skills; individuals must be able to disentangle complex information, clarify the logical relationships among its parts, and identify the main viewpoints and conclusions in a text. The second is evaluative ability. Evaluative ability refers to an individual's ability to make judgments about a text; it requires individuals to possess a certain reserve of knowledge and to use certain evaluative criteria to comprehensively judge the reliability of the information sources and the validity of the viewpoints and evidence expressed in the text. The third is inferential ability. Inferential ability is the core of critical thinking ability; individuals must be able to draw reasonable conclusions from existing information using logical reasoning methods. It requires individuals, when facing complex information, to be able to comprehensively use logic and evidence to infer their own conclusions from known premises.

3. CURRENT PROBLEMS IN THE CULTIVATION OF CRITICAL THINKING

3.1 Question Design Remains Superficial

Question design is a learned art. If questions are well designed, they can greatly mobilize students' learning enthusiasm and enhance classroom participation, and students can further understand what they have learned from the questions. However, in current classroom teaching, many teachers' question design is superficial and lacks systematic design, so that students sometimes find it difficult to correctly understand the teacher's questions, or the gaps between questions are relatively large. Such fragmented questions make students' thinking fragmented as well, and students do not experience a complete, gradually deepening process of critical thinking.

3.2 Insufficient Classroom Follow-up Questioning and Argumentation

At present, insufficient follow-up questioning and argumentation still commonly exist in classroom questioning, especially in secondary school classrooms. After posing a question, many teachers focus only on whether the student's answer is correct. If the answer is correct, they move on to the next question; if the answer is wrong, they ask another student to answer. They lack further follow-up questioning and do not attend to students' thinking processes. As a result, many students focus only on whether they can find the correct answer the teacher wants, and they often use expressions such as "I think" to organize their answers, which are highly subjective. Students rarely or never reflect on their own thinking processes, so their critical thinking is difficult to develop further and remains at a relatively low level.

3.3 Teaching Evaluation Overemphasizes Outcomes

The college entrance examination serves as the benchmark of school education, and its evaluation method directly affects the orientation of teachers' teaching behavior. Examinations organized by schools often only examine students' mastery of relevant knowledge points—that is, they center on knowledge memorization and the reproduction of standard answers—and do not attend to students' thinking development. This also leads many teachers to implement this concept in their daily teaching, valuing only the scores of each homework assignment and examination. In addition, schools' assessment and evaluation of teachers are also based on the examination scores of the classes they teach. However, the cultivation of critical thinking is a long-term, gradual process; short-term cultivation is unlikely to produce substantive results, and its effects are also difficult to quantify in the short term through standardized examinations. Moreover, school teaching evaluation often lacks process-oriented assessment of critical thinking cultivation. Even if teachers implement critical thinking cultivation in daily teaching, it is difficult for them to obtain clear recognition. Therefore, under the dual pressure of school assessment and teaching plans, many teachers choose to abandon this component of cultivation and instead invest their limited time and energy in knowledge lecturing that can be directly quantified.

4. PRINCIPLES FOR USING THE PROBLEM CONTINUUM TO CULTIVATE CRITICAL THINKING

4.1 The Principle of Contextualization

According to Piaget's theory of cognitive development stages, individual cognitive development passes through the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage in

sequence. In terms of age and general developmental level, senior high school students have usually entered the formal operational stage; their thinking begins to break free from the constraints of concrete things and direct experience, and they can think with the help of concepts, propositions, symbols, and logical relationships, and make hypotheses and deductions about things not yet directly presented. However, this ability is not yet stable. If it is completely detached from concrete contexts, students will bear an excessive cognitive load when analyzing problems, which instead imposes a burden on their thinking processes. Constructing a problem continuum based on concrete contexts can effectively avoid this problem. In addition, concrete contexts can also activate students' original cognitive experience and stimulate their interest in learning. The development of critical thinking requires students' sustained cognitive investment and places relatively high demands on students' willingness to continue inquiry. Only when students develop a relatively strong interest in the current problem can the subsequent series of critical thinking inquiry activities continue to advance.

4.2 The Principle of Gradual Progression

Critical thinking is a higher-order thinking, and its development exhibits stage-related characteristics. Based on long-term thinking teaching practice, Paul divided it into six progressively advancing stages; individuals need long-term practice to gradually form relatively stable thinking habits. Therefore, teachers need to grasp the principle of gradual progression when designing questions and cannot throw out open-ended questions at the beginning of class; otherwise, lacking prior question scaffolding, students will find it difficult to answer and their thinking will stagnate. According to the problem continuum theory, teachers can start from students' cognitive levels when designing questions. Specifically: first, use fact-level questions as an introduction to quickly mobilize students' learning interest and activate their existing cognitive experience. Then, use concept-level and generalization-level questions as the main body to advance the argumentation activities of the entire critical thinking classroom. Finally, use theory-level questions as an extension to purposefully raise students' depth of understanding, guide them to transfer critical thinking to the process of solving other problems, and promote the autonomous internalization of critical thinking.

4.3 The Principle of Student Agency

The cultivation of critical thinking emphasizes students' agency in rich problem inquiry activities. Teachers cannot think on behalf of students, nor can the personality traits and cognitive skills of critical thinking be acquired through teachers' lecturing. From the constructivist view of learning, learning is not the passive acceptance of knowledge but the construction of knowledge in a certain context and through cooperative interaction. Although teachers can explain critical thinking methods, if students do not personally experience the process of discovering problems, analyzing materials, seeking evidence, and forming judgments, these methods will be difficult to transform into actual critical thinking abilities. Based on the problem continuum theory, teachers can organize learning content through a series of interrelated problems, providing a carrier for students to participate in inquiry activities. However, when designing questions, teachers should note that they cannot directly provide the final conclusion; they should provide necessary cognitive scaffolding through timely follow-up questioning and prompts only when students' thinking stagnates or deviates from the core goal. The genuine processes of evidence collection and logical reasoning must all be completed by students themselves, ensuring that students remain the true subjects of this inquiry process.

5. STRATEGIES FOR USING THE PROBLEM CONTINUUM TO CULTIVATE CRITICAL THINKING

5.1 Delving Deeply into Teaching Texts to Identify Resources for Critical Thinking

The depth of teachers' interpretation of teaching texts directly determines the space for the development of students' critical thinking. This is especially true for the English subject: many texts in textbooks involve cross-cultural content, enabling students to come into contact with diverse cultures, experience customs and habits of different regions, and appreciate the collision of viewpoints produced under different backgrounds. When carrying out instructional design, teachers should deeply excavate the critical thinking resources contained therein, integrate them into question design, and run the cultivation of critical thinking through the entire teaching process. When discussing the critical dimension of English education, Lu Ziwen also emphasizes that English textbooks contain rich resources for cultivating critical thinking, and the key lies in whether teachers can discover and utilize them. It should be noted that teachers' deep excavation of critical thinking resources is not for the purpose of directly indoctrinating students with the results they have summarized, but rather for better designing questions at

different levels, thereby guiding students to think deeply step by step and discover the critical thinking resources contained therein for themselves, achieving the autonomous internalization of critical thinking.

5.2 Analyzing Instructional Content and Designing Progressively Sequenced Problem Sets

As a higher-order thinking, critical thinking has a complex and gradual development process. A single question can only touch one link of critical thinking, and fragmented questions can hardly form a synergy that drives the development of students' critical thinking; the development of students' critical thinking requires a gradual process from the surface to the inner. When discussing the cultivation of students' core competencies, Ding Fujun and others point out that setting main questions around core concepts and then designing sequenced sub-questions can effectively cultivate students' core competencies. The problem continuum theory provides guidance for constructing progressively sequenced problems. On the basis of analyzing instructional content, teachers can, according to the five problem types divided by this theory and corresponding to four cognitive levels, design a problem sequence that moves from closed to open, thereby guiding students to deepen their thinking processes. When designing problem sequences, teachers should attend to the following issues. First, the problem levels should be sequenced progressively. If teachers ask category-four or even category-five questions at the beginning of class, this may exceed students' cognitive load and cause their thinking to stagnate. Second, there should be logic among the problems: students' answers to the previous question can provide a knowledge foundation for the next question, and unrelated questions cannot simply be pieced together. Teachers should clarify the role and position of each question to ensure that the questions are closely linked. Finally, the design of the problem sequence should leave flexibility. Students' levels are usually uneven, and many novel angles may appear when they answer questions. Teachers should flexibly adjust according to students' answers, provide necessary scaffolding when students find it difficult to answer, and avoid interrupting classroom activities.

5.3 Optimizing Evaluation Methods and Attending to the Entire Process of Thinking Development

Traditional classroom teaching evaluation often relies mainly on paper-and-pencil tests, focusing on examining students' mastery of knowledge points and rarely attending to changes in students' thinking. However, the development of critical thinking is often gradual and implicit, and ordinary summative evaluation can hardly reveal changes in students' thinking. Based on the dimensions by which the problem continuum theory classifies different problems, teachers can construct critical thinking evaluation rubrics matching different problem types, thereby achieving layered, whole-process tracking of students' critical thinking development. At the same time, teachers can also set up a question-response portfolio for each student, recording each student's answers to different types of questions and using it as a carrier for learning diagnosis. This portfolio helps teachers understand the thinking level at which students are currently located and thereby adjust accordingly the difficulty gradient and questioning angles of the problems in the problem continuum.

In addition, teachers can introduce student self-assessment and peer assessment. Based on the hierarchical standards of the problem continuum, they can design simple self-assessment and peer-assessment rules, guiding students to reflect on whether their argumentation processes are logically self-consistent after completing inquiry into problems at different levels. Peers can also, according to different evaluation criteria, point out each other's thinking loopholes, and teachers can guide students to discover their own cognitive blind spots from the perspective of peers, promoting students to calibrate their own viewpoints on their own.

5.4 Optimizing Teacher–Student Interaction and Creating an Open and Inclusive Classroom for Critical Inquiry

The development of critical thinking requires not only high-quality questions and follow-up questioning but also a suitable classroom environment as support. The quality of classroom interaction directly affects the manifestation of students' critical thinking. Effective classroom questioning lies not only in the design of the questions themselves but also in the teacher's response to and interaction with students' answers. Teachers need to create a safe, open dialogue environment through active listening, timely follow-up questioning, and constructive feedback, so that students dare to express different viewpoints and are willing to think deeply. When discussing the classroom teaching process, Ye Lan also emphasizes that classroom teaching is a complex dynamic process; teachers should attend to the generative resources in the classroom, respect students' different views, and promote the development of students' thinking in teacher–student interaction.

Optimizing teacher–student interaction first requires transforming teachers' role positioning. In traditional reading

classrooms, the core of teacher–student interaction is "the teacher checks whether students have mastered the correct answer." In teaching based on the problem continuum theory, teachers should transform into the roles of thinking guides and dialogue facilitators, not fixating on whether students' answers are correct but focusing on the process of their thinking changes. Optimizing teacher–student interaction also requires establishing a positive classroom feedback mechanism. In traditional classrooms, teachers' feedback on students' answers is often simple evaluation such as "right" or "wrong", attending only to the correctness of the conclusion and not to the thinking process. In teaching based on the problem continuum theory, teachers should adopt more detailed feedback methods: on the one hand, giving specific feedback on students' thinking processes; on the other hand, guiding students to think further through feedback.

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