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# A Study on the Current Status and Strategies for Cultivating Higher-Order Thinking in High School Information Technology Courses in the Digital Age

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## Abstract

**In the era of educational digitalization, higher-order thinking skills are considered essential core competencies for students to tackle complex problems and face future challenges. In this context, information technology courses bear greater responsibility, becoming one of the key platforms for cultivating students' higher-order thinking skills. This study investigates the current status of higher-order thinking in high school information technology courses through questionnaires and in-depth interviews. The findings reveal that while students generally perform well, they exhibit weaker performance in problem-solving and creative thinking abilities. Based on the survey analysis, the study proposes teaching strategies for cultivating students' higher-order thinking skills in the digital age.**

## Keywords

**Higher-order thinking; high school information technology; educational digitization; skill development.**

## 1. Introduction

Higher Order Thinking (HOT) is a focal point of current international educational research and a key competency essential for 21st-century talent. Education sectors worldwide place great emphasis on its cultivation. The 2016 World Innovation Summit for Education (WISE) report titled "Learning for the Future: The Global Experience of Core 21st Century Skills Education" identified higher-order thinking as an integral part of 21st-century core competencies. Moreover, the innovative capability within higher-order thinking was included in the Programme for International Student Assessment (PISA) in 2022. In 2023, the OECD's Centre for Educational Research and Innovation (CERI) released a report titled "Fostering Students' Creativity and Critical Thinking Skills in Higher Education: Policy and Practice," which focused on assessment methods for students' creative and critical thinking skills, further emphasizing the importance of higher-order thinking in education.

Simultaneously, China released the "China Smart Education Blue Book (2022)" at the World Digital Education Conference in 2023, advocating for the cultivation of students' higher-order thinking, comprehensive innovation abilities, and lifelong learning skills, placing higher-order thinking at the forefront of educational reform. Information technology courses, as a distinct discipline, possess characteristics such as technicality, practicality, openness, and comprehensiveness, making information technology classrooms an important platform for fostering higher-order thinking. The new curriculum standards released in 2022 officially renamed the "Information Technology" course to "Information Science and Technology." The

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standards highlight the importance of guiding students through practical activities to cultivate their innovative awareness, critical thinking, problem-solving skills, and other higher-order thinking abilities, thereby promoting the development of core competencies.

## 2. Research Background

Foreign scholars have begun researching higher-order thinking skills (HOTS) relatively early and have produced abundant studies, recently focusing on influencing factors and cultivation strategies. HOTS have been a focus of various studies across different disciplines. Utama et al. (2020) developed an instrument to measure HOTS for pre-service biology teachers [1] . Febriyani et al. (2020) conducted an analysis on HOTS in compulsory English textbooks for twelfth-grade students in Indonesian senior high schools [2]. Lu et al. (2021) examined the key influencing factors on college students' HOTS in a smart classroom environment[3]. In the context of education, Wijnen et al. (2021) developed and validated a questionnaire to measure primary school teachers' attitudes towards stimulating higher-order thinking in students [4] . Ghosh et al. (2023) evaluated ChatGPT's ability to solve higher-order questions in the competency-based medical education curriculum, highlighting the importance of higher cognitive thinking in AI systems [5]. Additionally, Eliyasni et al. (2019) studied the impact of blended learning and project-based learning on improving students' HOTS [6]. These studies collectively contribute to the understanding and development of higher-order thinking skills across various educational contexts.

At present, research on higher-order thinking (HOT) in China mainly focuses on its connotation, cultivation, and evaluation. Ma Shufeng and Yang Xiangdong view higher-order thinking as a systematic thinking model that includes cognitive and metacognitive processes [7]. Sun Hongzhi, Xie Yueguang, and others have explored the design process and methods of performance evaluation for the development of higher-order thinking under the guidance of core competencies [8]. Pan Qingyu suggests that developing higher-order thinking in Chinese language studies involves tapping into the thinking potential of texts and knowledge to evoke students' cognitive experiences[9]. Liu Yiming proposes that information technology teachers can cultivate students' higher-order thinking through programming thinking, transformative thinking, innovative thinking, critical thinking, and modeling abilities [10]. Qu Xiaojun believes that higher-order thinking can be cultivated through deep learning and proposes high school information technology teaching strategies aimed at fostering higher-order thinking [11].

The cultivation of higher-order thinking skills holds a crucial position in different cultural and educational systems worldwide. The academic community has conducted in-depth research from multiple perspectives, especially focusing on how to effectively nurture these skills across various educational stages and disciplines. However, despite extensive research, there is still a lack of in-depth study and application of higher-order thinking skills in information technology courses, highlighting the need for further research and practical application.

## 3. Research Methodology

### 3.1. Research Objectives

This study aims to investigate the current status of higher-order thinking skills in high school academic information technology courses. It seeks to analyze the weaknesses and underlying reasons in the current state of higher-order thinking skills within these courses. Based on the survey results and the educational requirements of the digital information age, the study proposes effective strategies for cultivating higher-order thinking skills in high school students' information technology education.

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## 3.2. Data Sources

This study selected 224 students from the second grade of X School in Kunming city as research subjects. Surveys were distributed online via Questionnaire Star, with a total of 224 questionnaires distributed and 220 valid responses collected, resulting in an effective response rate of approximately 98%.

## 3.3. Research Tools

This study employed both questionnaire surveys and interviews to investigate higher-order thinking in high school information technology.

### 3.3.1. Questionnaire Design and Analysis of Reliability and Validity

Professor Zhong Zhixian's definition of higher-order thinking has been widely recognized and applied by domestic researchers. It is divided into four dimensions: creative thinking ability, problem-solving thinking ability, decision-making thinking ability, and critical thinking ability. Based on this foundation, combined with Bloom's cognitive objective classification and suggestions from mentors and frontline teachers, this study ultimately determined the analysis of decision-making ability, critical thinking ability, problem-solving ability, and creative thinking ability as the primary indicators for the questionnaire.

The analysis of decision-making ability refers to the student's ability to analyze the question, extract key information, categorize and summarize the internal connections of knowledge, and find wise and appropriate problem-solving methods. It is divided into four secondary indicators, with a total of five questions. Critical thinking requires the examination of the quality of reasoning and logical consistency, while also paying attention to detecting biases, positions, intentions, assumptions, and viewpoints, whether explicitly stated or not, so as to assess the rationality from various perspectives, argue and evaluate the value and significance of things, and predict possible consequences [12]. It is divided into four secondary indicators, with a total of five questions. Problem-solving ability represents students' comprehensive application of knowledge [13], reflecting their proactive attitude when faced with problems, their ability to flexibly apply appropriate processing methods, objectively evaluate problems, and engage in deep reflection. It is divided into three secondary indicators, with a total of five questions. Creative thinking refers to the Williams Creativity Tendency Scale, combined with the exploratory, challenging, and innovative characteristics of information technology courses. It is divided into three secondary indicators, with a total of five questions.

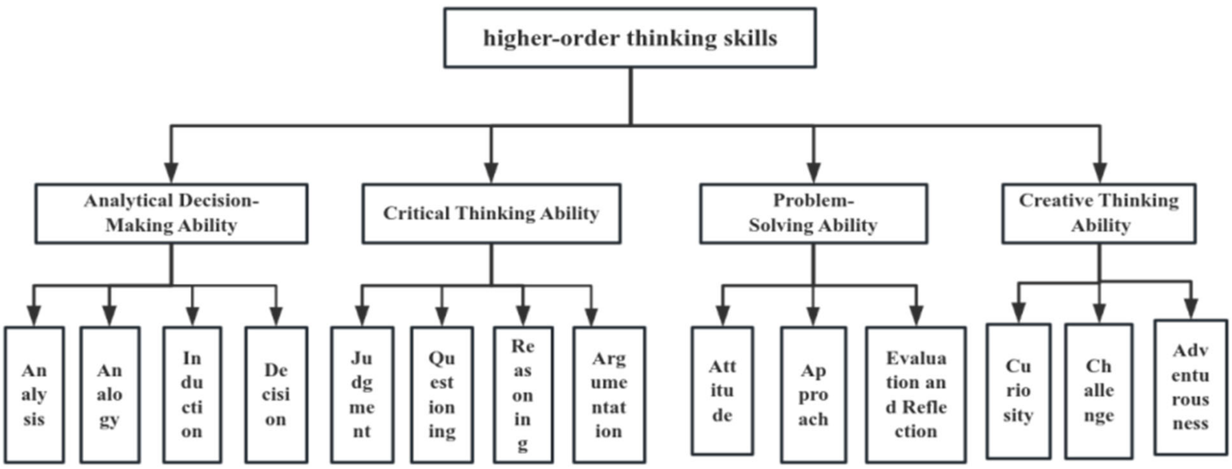


**Figure 1.** Questionnaire Dimension Indicator Chart

The purpose of reliability analysis is to verify the authenticity and reliability of the data, while validity analysis assesses the effectiveness of the questionnaire survey. In this study, SPSS 27

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was used for reliability and validity analysis. Reliability was assessed using Cronbach's alpha coefficient, and the calculated internal consistency coefficient was 0.939, indicating a good level of internal consistency for the questionnaire. Validity was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The KMO coefficient was 0.892, greater than 0.8, and Bartlett's test yielded a significance value of 0.000, less than 0.05, indicating good validity for the questionnaire.

### 3.3.2. Interview

This study designed three open-ended interview questions to interview teachers, aiming to explore the current perspectives of information technology teachers on higher-order thinking and classroom assessment methods.

# 4. Research Analysis

## 4.1. Research Analysis

### 4.1.1. Questionnaire Data Analysis

Statistical Analysis of Overall Dimensions of Higher-Order Thinking:The 220 valid questionnaires were processed using SPSS 27, and descriptive statistics were conducted for the four dimensions of higher-order thinking. Each question was scored on a scale ranging from 1 to 5. The results are presented in Figure 2.

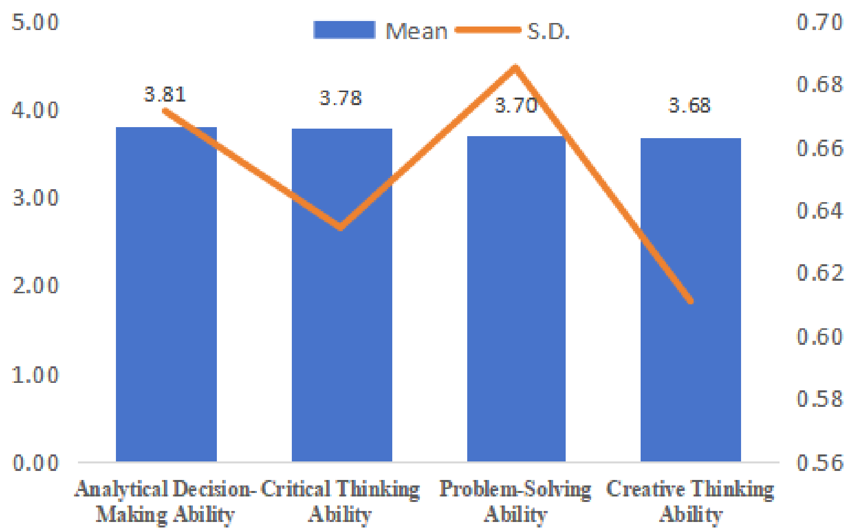


**Figure 2.** Primary Dimension Descriptive Statistics Chart

Based on Figure 2, it can be observed that the overall higher-order thinking ability of high school students is slightly above average, but there are differences among different abilities. Specifically, the mean score for decision-making ability is 3.81, for critical thinking ability is 3.78, for problem-solving ability is 3.70, and for creative thinking ability is 3.68. Among these, problem-solving ability and creative thinking ability have slightly lower scores compared to the former two, indicating relative deficiencies in these areas, which require special attention and cultivation. From the perspective of standard deviation, the values for decision-making ability and problem-solving ability are relatively high, implying significant individual differences in these two aspects among students, with their performances varying significantly and dispersed. Therefore, teachers should focus on optimizing and improving students' weaknesses, pay attention to the diversity of thinking, tailor instruction to individual needs, and meet the learning needs of different students in a targeted manner.

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Dimensional Analysis: *Descriptive analysis of secondary indicators within each dimension was conducted to further explore specific areas where students' ability levels are relatively low.*

Analytical Decision-Making Ability: Based on the descriptive statistics of the secondary indicators of analytical decision-making ability, the results indicate that the mean score of the analysis dimension is the highest. This suggests that students are generally proficient in analyzing and understanding the core elements of a problem, thereby facilitating better problem-solving. The means of the other three dimensions do not vary significantly and are all at a moderately high level. However, comparatively, the decision-making dimension exhibits the lowest mean score and the greatest variability. Further analysis of the response options reveals that nearly half of the students selected options that are average or below average. This may indicate that students often exhibit hesitation when choosing the correct and concise problem-solving method or lack clear decision-making criteria when faced with multiple choices.

**Table 1.** Analytical Decision-Making Ability Dimensions Table

| Dimension | N | Min. | Max. | Mean | S.D. |
|---|---|---|---|---|---|
| Analysis | 220 | 2 | 5 | 4.06 | 0.825 |
| Analogy | 220 | 2 | 5 | 3.76 | 0.762 |
| Induction | 220 | 2 | 5 | 3.73 | 0.825 |
| Decision | 220 | 1 | 5 | 3.72 | 0.912 |

Critical Thinking Ability: According to the chart, within the dimensions of critical thinking ability, the judgment dimension has the highest mean and the smallest standard deviation. This indicates that most students possess good judgment and discernment when faced with issues or viewpoints, and this ability level is relatively consistent among them. However, in terms of questioning, students' performance is relatively lacking, with 51% of students selecting average or below-average options. This suggests that the majority of students are not inclined to express their thoughts when they have doubts. This situation may hinder their in-depth thinking about issues and comprehensive understanding of different viewpoints.

**Table 2.** Critical Thinking Ability Dimension Table

| Dimension | N | Min. | Max. | Mean | S.D. |
|---|---|---|---|---|---|
| Judgment | 220 | 3 | 5 | 3.90 | 0.615 |
| Questioning | 220 | 1 | 5 | 3.55 | 0.938 |
| Reasoning | 220 | 1 | 5 | 3.69 | 0.879 |
| Argumentation | 220 | 1 | 5 | 3.86 | 0.876 |

Problem-Solving Ability: In the realm of problem-solving ability, the dimension of evaluation and reflection has the highest mean and the smallest standard deviation. This indicates that students' abilities are converging at a relatively high level, meaning that most students tend to summarize and reflect after learning. They are able to effectively evaluate the problem-solving process and learn from their experiences. Among the dimensions, the handling approach indicator has the lowest mean, with nearly half of the students scoring 3 or below. This suggests that some students lack flexibility in dealing with problems and have weaker deconstruction abilities.

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**Table 3.** Problem-Solving Ability Dimension Table

| Dimension | N | Min. | Max. | Mean | S.D. |
|---|---|---|---|---|---|
| Attitude | 220 | 1 | 5 | 3.72 | 0.898 |
| Approach | 220 | 1 | 5 | 3.65 | 0.810 |
| Evaluation and Reflection | 220 | 1 | 5 | 3.74 | 0.673 |

Creative Thinking Ability: Statistical analysis of the sample reveals that the curiosity dimension has the highest mean, indicating that students generally exhibit a high level of curiosity and interest in new things and knowledge. On the other hand, the risk-taking dimension has the lowest mean, with 51.7% of students scoring below 3. This means that individuals have a relatively weak inclination towards taking risks and exploring new experiences. This trend reflects a conservative approach in students' exploration and innovation. While they possess strong curiosity, their low acceptance of risk-taking may limit their enthusiasm and courage when facing unknown areas.

**Table 4.** Creative Thinking Dimension Table

| Dimension | N | Min. | Max. | Mean | S.D. |
|---|---|---|---|---|---|
| Curiosity | 220 | 2 | 5 | 4.04 | 0.752 |
| Challenge | 220 | 3 | 5 | 3.70 | 0.685 |
| Adventurousness | 220 | 1 | 5 | 3.49 | 0.798 |

Differential Analysis: To examine whether gender differences have an impact on the higher-order thinking abilities of high school students, a independent samples t-test was conducted with the four dimensions of higher-order thinking ability as dependent variables and gender as the independent variable. The results are summarized in the following table:

**Table 5.** Group T -test

| Dimension | Gender (M+SD) | | T | P |
|---|---|---|---|---|
| | Male (N=111) | Female(N=109) | | |
| Analytical Decision-Making Ability | 3.85+0.66 | 3.77+0.69 | 0.902 | 0.368 |
| Critical Thinking Ability | 3.90+0.64 | 3.66+0.61 | 2.879 | 0.004 |
| Problem-Solving Ability | 3.81+0.65 | 3.59+0.70 | 2.470 | 0.014 |
| Creative Thinking Ability | 3.76+0.59 | 3.60+0.62 | 1.868 | 0.063 |

The table indicates that male and female students show some differences in various dimensions of higher-order thinking abilities. In decision-making ability, males scored 3.85 and females scored 3.77, with a p-value of 0.368, indicating no significant difference. In creative thinking ability, males scored 3.76 and females scored 3.59, showing slightly higher scores for males but not significantly different. However, in critical thinking ability (p-value=0.004) and problem-solving ability (p-value=0.014), males significantly outperformed females. Female standard deviations in decision-making, problem-solving, and creative thinking were higher, suggesting greater variability in female thinking abilities.

## 4.2. Interview Text Analysis

After conducting in-depth interviews with seven high school information technology teachers, the study found that about 70% of respondents had inadequate understanding of higher-order

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thinking concepts, primarily reflected in their vague definitions of higher-order thinking and unfamiliarity with relevant theoretical frameworks. Additionally, these teachers generally lacked effective methods and strategies for assessing and measuring students' higher-order thinking abilities. This finding suggests the need to enhance teachers' professional training in higher-order thinking pedagogy to better promote students' cognitive development.

## 5. Results Discussion

### 5.1. Student's Perspective

Based on the analysis of questionnaire data, the following conclusions can be drawn:(1) Overall, high school students' levels of higher-order thinking in information technology are above average, but there are deficiencies in various aspects. Particularly, in terms of creative thinking, students demonstrate relatively weaker abilities, with an average score of only 3.68. Further data analysis reveals that the adventurousness index not only has the lowest score (3.49), but also the largest standard deviation (0.798), indicating significant variability in students' performance in this sub-dimension. Additionally, the assessment of problem-solving abilities reveals significant performance differences, with the highest standard deviation (0.68), implying inconsistency among students in this ability dimension. Specifically, students often lack a proactive attitude when facing problems and demonstrate low adaptability and flexibility in problem-solving processes. This trend is reflected in the assessment method indicator, where students receive the lowest average score (3.65), and show the highest standard deviation (0.898) in attitude measurement, which may reflect widespread difficulties in problem-solving processes and potential needs for teaching intervention.(2)The significant differences (p-value $< 0.05$) between male and female students in critical thinking ability and problem-solving ability indicate that males have relative advantages in these two aspects. However, the differences in female students' abilities are more significant, also reflecting the broader diversity among individuals in cognitive styles, learning experiences, or intrinsic motivations. Educational intervention measures should take into account these gender differences to develop more personalized and targeted teaching methods, while encouraging all students, especially females, to develop and enhance their critical thinking and problem-solving skills.

### 5.2. Teacher's Perspective

The analysis of interview texts reveals that teachers have inadequate understanding of cultivating students' higher-order thinking using new technologies: (1) Lack of understanding of higher-order thinking concepts and failure to recognize their importance in teaching. (2) The assessment methods for higher-order thinking abilities appear to be limited, and in some cases, completely absent. These findings may point to avenues for exploration in educational practices aimed at cultivating higher-order thinking in information technology: enhancing teachers' understanding of higher-order thinking, diversifying assessment methods, and integrating new technologies into teaching strategies

## 6. Suggestions

### 6.1. Shift mindset, enhance awareness in cultivating higher-order thinking in information technology.

To foster the development of higher-order thinking abilities, the field of information technology education must revolutionize outdated educational paradigms. This transformation requires collaboration among schools, IT teachers, and students to establish a dynamic collaborative structure with schools at the forefront, teachers as the core driving force, and students actively participating. Schools guide teachers in shifting their mindset, providing professional

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development and training. Teachers innovate methods, explore teaching models that align with contemporary trends, and stimulate student interest and potential. Students actively engage in learning under the guidance of teachers, ultimately achieving a shift in awareness, breaking traditional constraints, and strengthening higher-order thinking.

### 6.2. Incorporating the characteristics of contemporary education, restructure new strategies for higher-order information technology classroom teaching.

The essence of teaching higher-order thinking should involve deep restructuring of knowledge, leading to profound and meaningful learning. To align with the trend of digital education, information technology courses need to reconstruct effective teaching strategies, taking into account the potential impact of gender differences on learning, especially in cultivating critical thinking and problem-solving abilities among female students. Additionally, curriculum design should be centered around problems and driven by tasks, leveraging digital tools to facilitate inquiry-based learning. Furthermore, advocating for maker education and breaking down disciplinary barriers, integrating digital means into teaching, and incorporating technologies such as VR, AR, and metaverse to create immersive virtual learning environments, stimulate student interest, cultivate higher-order thinking, and establish advanced classroom models.

### 6.3. Establish a diversified evaluation system aimed at cultivating higher-order thinking.

In the digital information age, diversified evaluation methods are needed for assessing higher-order thinking in the field of information technology. These may include inter-group evaluation, intra-group evaluation, teacher assessment, and student self-assessment. Teachers can use multimedia devices for real-time questioning, provide feedback, and facilitate the development of students' high-level thinking, thus improving problem-solving efficiency. Additionally, encouraging students to submit their work to learning platforms and combining data analysis of students' completion of tasks can help educators quickly understand students' learning status and provide personalized support, leveraging big data and cloud computing.

## 7. Conclusion

In the era of digital education, higher-order thinking abilities have become the core of comprehensive talent qualities. They not only represent key competencies in various subjects but also encompass the emotional attitudes and values of core subject literacy. With the transformation of talent training into digital and informational formats, the close connection with the discipline of information technology becomes increasingly apparent. This connection makes it particularly crucial for students to cultivate higher-order thinking abilities in digital environments. Through in-depth learning and practical application of information technology disciplines, students are able to continuously enhance their thinking abilities in the context of solving real-world problems, promoting the comprehensive development of higher-order thinking. Moreover, they are better equipped to adapt to the complex challenges and demands of the digital age.

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## References

[1] C. Utama, S. Sajidan, J. Nurkamto, and W. Wiranto, “The Instrument Development to Measure Higher-Order Thinking Skills for Pre-Service Biology Teacher,” International Journal of Instruction, vol. 13, no. 4, pp. 833–848, Oct. 2020.

[2] A. Saptono, S. Suparno, A. Wibowo, E. Ahman, I. Ismiyati, and D. Sukayugi, “An Analysis of Higher-Order Thinking Skills (HOTS) in the Learning of Economics,” JOURNAL OF ELECTRICAL ENGINEERING & TECHNOLOGY, vol. 19, no. 4, pp. 268–290, Apr. 2020.

[3] K. Lu, H. H. Yang, Y. Shi, and X. Wang, “Examining the key influencing factors on college students’ higher-order thinking skills in the smart classroom environment,” International Journal of Educational Technology in Higher Education, vol. 18, no. 1, Jan. 2021.

[4] F. Wijnen, J. W. van der Molen, and J. Voogt, “Measuring primary school teachers’ attitudes towards stimulating higher-order thinking (SHOT) in students: Development and validation of the SHOT questionnaire,” Thinking Skills and Creativity, p. 100954, Sep. 2021.

[5] Ghosh, A., & Bir, A. “Evaluating ChatGPT's Ability to Solve Higher-Order Questions on the Competency-Based Medical Education Curriculum in Medical Biochemistry.” Cureus, Apr.2023.

[6] R. Eliyasni, A. K. Kenedi, and I. M. Sayer, “Blended Learning and Project Based Learning: The Method to Improve Students’ Higher Order Thinking Skill (HOTS),” Jurnal Iqra’ : Kajian Ilmu Pendidikan, vol. 4, no. 2, pp. 231–248, Dec..

[7] Shufeng Ma, Xiangdong Yang. What is High-Level Thinking? — A Conceptual Framework Centered on the Relationship Between New and Old Knowledge. Journal of East China Normal University (Educational Sciences Edition), 2022, 40(11): 58-68.

[8] Hongzhi Sun, Yuexue Xie, Yu Zhang. Design of Performance Evaluation for the Development of High-Level Thinking under Core Competency Orientation. Research on Educational Technology, 2021, 42(09): 91-98.

[9] Qingyu Pan. Cultivating High-Level Thinking in the Chinese Language Discipline. Language Construction, 2021(23): 4-9. DOI:10.16412/j.cnki.1001-8476.2021.23.004.

[10] Yiming Liu. How to Cultivate Students' High-Level Thinking in High School Information Technology Teaching. Contemporary Family Education, 2023, (23): 76-78.

[11] Xiaojun Qu. Teaching Large Units in High School Information Technology Aimed at Cultivating High-Level Thinking. Secondary School Curriculum Guidance, 2024, (02): 117-119.

[12] Rude Liu. On the Meaning and Connotation of Critical Thinking. Research on Higher Teacher Education, 2000, (01): 56-61.

[13] Yuanyue Wu, Weiqi Xie. Problem-Solving Ability: Connotation, Structure, and Cultivation. Educational Research and Experiment, 2013(04): 48-51.