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Cultivation of College Students' Information Skills and Innovation Literacy under the Background of New Liberal Arts

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Abstract: *In the context of the new liberal arts construction emphasizing interdisciplinary and digital humanities, liberal arts college students generally face the core contradiction of information overload and insufficient ability to accurately obtain, analyze, and innovate applications. To this end, this study first systematically analyzes the current status and bottlenecks of liberal arts students' information skills and innovation literacy. Then, this paper integrates modules such as information retrieval, data analysis, critical thinking, and interdisciplinary project design. Then, it develops and implements an innovative training program, and finally, it relies on an online and offline hybrid teaching platform for practice. Experimental data show that students scored an average of 6.94 points in information retrieval accuracy; in the innovation project, creativity scored the highest (7.60 points), while presentation ability was weak (6.32 points). In the critical thinking experiment, the problem identification ability scored 7.09 points, while the depth of reflection and strategic rationality were relatively weak, with an average of only 6.49 points and 6.55 points. The research results show that this systematic training program can improve students' basic information capabilities while exposing the shortcomings of current high-level cognitive training, providing direction and data support for future teaching reforms.*

Keywords: *New Liberal Arts Construction; Information Literacy Training; Innovation Ability Improvement; Critical Thinking Training; Digital Humanities Project*

1. Introduction

Under the background of the construction of new liberal arts, traditional liberal arts education is facing a dual transformation of concepts and methods. Especially driven by the rapid development of information technology, college students are in urgent need of stronger information acquisition, analysis and innovative application capabilities. However, current liberal arts students generally have problems such as weak practice, shallow thinking and poor integration in information literacy and innovation ability, making it difficult for them to adapt to the requirements of new talent training in an interdisciplinary and digital context. Therefore, exploring a systematic and effective training mechanism is of practical significance for improving students' core literacy and is also of great value for deepening the reform of new liberal arts education.

This paper focuses on the coordinated improvement of college students' information skills and innovative literacy, and proposes a comprehensive training program that integrates information retrieval, data analysis, critical thinking and project practice. The program integrates task-driven, collaborative learning and digital humanities project training, and focuses on the contextualization, interactivity and application orientation of teaching. Through experimental verification, this study has constructed a talent training path that is effective in practice and has a clear structure, enriching the theoretical and practical exploration of the integrated training of information ability and innovation literacy under the background of the new liberal arts.

The paper is divided into four parts. First, the introduction introduces the research background, problem raising and research significance; the second part elaborates on the design logic and module composition of the training program. The third part shows and analyzes the student performance and evaluation results in each experimental link. Finally, the conclusion summarizes the research findings, points out the problems in current teaching, and puts forward suggestions for improvement and future

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prospects.

2. Related Works

In recent years, many scholars have explored the research on college students' information skills and innovation literacy. For example, in the era of information explosion, Wang et al. designed a new general information literacy framework and evaluated its effectiveness through questionnaires. The results showed that the information literacy level of graduate students gradually improved, and the course evaluation also showed a high level of satisfaction [1]. Shi et al. proposed a model for improving college students' information literacy based on an intelligent learning environment, explored its role in promoting the spiral development of information literacy, and demonstrated the positive impact of this study on the sustainable development of information literacy training [2]. Khan et al. surveyed 300 young people and found that key skills, operational skills, learning styles, and learning systems can improve digital literacy, thereby improving academic performance and employability, providing solutions for cultivating digitally literate graduates [3]. Vodă et al. filled the academic gap in the field of digital literacy by analyzing the predictors of digital literacy for different types of students, emphasizing it as a fundamental competency for success in higher education and professions[4]. Novia et al. improved English proficiency by developing students' critical thinking, creativity, communication and teamwork skills, and strengthening social skills and global awareness[5]. Mahanal et al. used a parallel embedded mixed methods design to evaluate the continuous development of problem-solving skills among students of different academic abilities in the Department of Biological Education at a state university in Indonesia[6]. Peled et al. aimed to assess the digital literacy and digital readiness of education students to determine teachers' digital readiness in terms of the basic skills needed to help students integrate into society[7]. Ningrum and Sudarwati aimed to develop a critical reading test for Indonesian English learners to assess students' progress and provide accurate and reliable results, thereby addressing the reasons why students lack critical reading skills[8]. However, existing research focuses on the theoretical connection between a single subject or information skills and innovation literacy, lacking systematic and multi-level practical guidance.

The literature shows that the cultivation of information skills and innovation literacy requires multi-angle strategies and methods. For example, Peiyuan proposed an innovative junior high school information technology design learning model based on ability training based on the theory of "hands-on inquiry learning" and constructivism, which provides a reference for international scholars to construct a 21st century skill training teaching model [9]. Zhao explored the effect of light on watermelon growth through a project-based learning model, combining data query, field research, labor practice and summary reflection to cultivate students' inquiry ability and promote the development of core literacy [10]. Li and Cui analyzed the difficulties of five-direction education in chemistry teaching, constructed an interdisciplinary project-based learning model, and designed a "emulsion production" case, which promoted the integration of educational concepts and chemistry disciplines and cultivated students' comprehensive literacy and innovation ability [11]. However, these methods still have certain limitations in practical application, mainly reflected in the lack of comprehensive stimulation of students' independent innovation ability. To this end, this paper combines modern educational technology with innovative thinking training and proposes a teaching model based on the dual cultivation of information skills and innovative literacy, aiming to fill the gap in existing research.

3. Methods

3.1 Information Skills Module Design

Table 1 Information skills module teaching arrangement list

Submodule Name	Instructional Hours	Number of Assigned Tasks	Recommended Group Size
Information Retrieval Training	4	2	3 students per group
Text Mining Tools Application	6	2	2 students per group
Data Integration and Visualization	3	1	3 students per group
Information Expression and Formatting	2	1	Individual task

In response to the common problems of students in the survey, such as one-sided information acquisition, single tool use, and in-depth analysis, the information skills module sets up four sub-units based on the ability structure, including information retrieval method training, text mining tool

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application, data integration skills, and information expression standards, to form a systematic teaching content. Each sub-module has also been scientifically arranged in terms of teaching time, number of tasks, and grouping form. The specific content is shown in Table 1.

In terms of information retrieval, the course guides students to master the skills of keyword construction, Boolean logic application, database screening and document management, and focuses on training their ability to accurately locate and make critical judgments on different retrieval platforms. In view of the fact that students previously had only one source of information, the module introduces multi-platform parallel retrieval tasks, encourages students to cross-validate between Chinese databases and international resources, and improves source diversity and discrimination capabilities.

Text mining and data integration training focuses on improving students' ability to process and analyze unstructured texts. Entry-level tools such as NVivo are used to carry out practical operations such as keyword extraction, word frequency analysis, and opinion clustering, guiding students to extract valuable information structures from raw data. For example, the keyword weight calculation is as shown in formula (1):

$$\mathrm{TF-IDF(t,d)} = \mathrm{TF(t,d)} \times \log\left(\frac{\mathrm{N}}{\mathrm{DF(t)}}\right) \tag{1}$$

$\mathrm{TF(t,d)}$ represents the frequency of occurrence of term t in document d, N is the total number of documents, and $\mathrm{DF(t)}$ is the number of documents containing term t. Through the simulation operation of situational cases, students gradually master the basic logic and process of data processing. Finally, the module also sets up information standard expression training, covering data visualization, reference format specifications, logical structure expression and other aspects, to strengthen students' information presentation awareness and output quality, and help them establish a complete information processing closed loop from acquisition to processing and then to presentation [12].

3.2 Critical Thinking and Interdisciplinary Project Design

Critical thinking and interdisciplinary project design aims to guide students to conduct multi-dimensional analysis, independent thinking and teamwork in complex situations, and improve their comprehensive judgment and innovative design capabilities. In terms of critical thinking training, the teaching adopts a step-by-step guidance of "proposing a point of view - structural argumentation - evidence support - logical refutation - point of view reconstruction". Through the analysis of text materials such as current political hot spots, cultural phenomena and social issues, students are guided to identify implicit assumptions, logical loopholes and missing evidence, and gradually establish a clear and powerful thinking framework [13].

In the interdisciplinary project design part, the module takes "problem-oriented + subject integration" as the core strategy, selects topics such as environmental protection, cultural heritage protection, and urban development, and requires students to work together in groups to analyze issues from multiple perspectives such as humanities, society, technology, and art, and finally form solutions with application value. During the implementation of the project, teachers provide phased guidance and process feedback to ensure that students constantly adjust their thinking, integrate resources, and deepen their cognition in cooperation.

3.3 Contextualized Task-Driven and Collaborative Learning

The contextualized task-driven and collaborative learning module closely follows the concept of "learning by use" advocated by the new liberal arts, focusing on how students can flexibly apply the knowledge they have learned to innovative practice in the actual information environment. In terms of task design, the module selects problem situations that are close to students' professional backgrounds and social hot spots, such as "Analysis of cultural misunderstandings in short videos", "Suggestions for optimizing university information service platforms", "Paths for digital communication of local intangible cultural heritage", etc., and combines key ability requirements such as information retrieval, text analysis, viewpoint construction and program output to build a task system with a complete structure and clear goals. Each task has a clear output form, such as research reports, proposal presentations or digital works, to ensure that the task drive is completion-oriented and effective.

The collaborative learning part is carried out in groups. Team members need to have clear division of labor, work together to promote tasks, and constantly negotiate roles and share information in the process. The teacher does not intervene directly in this process, but provides necessary resource support

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and process feedback as a guide. In order to strengthen the collaborative effect, the module introduces a process evaluation mechanism, which encourages students to reflect on the shortcomings and improvement directions of the collaborative process through group logs, stage reports and mutual evaluation systems.

In addition, to cope with different task complexities, the module rationally arranges online and offline hybrid collaboration spaces, such as using a learning management system for data sharing and manuscript co-creation, and organizing offline special discussions and achievement presentations, to give full play to the team learning effectiveness under technical support. In the project achievement evaluation, a multi-dimensional assessment is performed with the help of the comprehensive scoring function formula (2):

$$T = \frac{1}{n}\sum_{i=1}^{n}(w_1 A_i + w_2 B_i + w_3 C_i) \quad (2)$$

A_i, B_i, C_i represent the students' scores in content quality, technology application, and expression effect, respectively; w_1, w_2, w_3 are the corresponding weights; and n is the number of people in the group. Overall, this module not only improves students' ability to complete tasks, but also strengthens their comprehensive qualities such as information integration, communication expression, and collaborative innovation in real contexts [14].

3.4 Digital Humanities Project Training

The digital humanities project training module is a comprehensive improvement link of this research and training system. The project topics focus on core issues of liberal arts such as culture, history, and society, and combine available open data resources with local cultural materials. Students can be encouraged to independently form project teams around themes such as "constructing urban memory maps", "arranging digital archives of local dialects", and "visualizing the history of universities" to carry out information collection, data analysis, and content expression. During the project, students need to use digital tools such as text mining tools and visualization platforms (such as Tableau, ArcGIS, and ROST) to complete the extraction, structuring, and multimodal presentation of materials.

In terms of teaching arrangements, the training is divided into three stages: preparation, execution, and presentation (as shown in Table 2).

Table 2 Basic structure and technology application distribution of digital humanities project training

Project Phase	Number of Technical Tools	Number of Data Types	Number of Output Formats
Preparation	2	1	0
Implementation	3–4	2	1
Presentation	1–2	2	2–3

The preparation stage includes project design and tool training; the execution stage focuses on data operation and content production; the presentation stage requires students to present the results in various forms such as reports, videos, interactive web pages or virtual exhibition halls, and make public reports. The teacher provides full-process guidance and node evaluation to ensure that each group meets the standards in terms of technical application and content logic.

4. Results and Discussion

(1) Information retrieval and analysis ability assessment experiment

This experiment aims to assess college students' performance in information retrieval and analysis ability. By designing a series of data analysis and information retrieval activities based on practical tasks, students need to use a variety of information sources and analysis tools to complete data organization, analysis and visualization. The experiment comprehensively examines students' ability to process information and conduct critical analysis through three dimensions: retrieval accuracy, source diversity, and analysis depth. After data collection, students' performance can be quantitatively evaluated through multiple statistical indicators. The specific data is shown in Figure 1.

In Figure 1, retrieval accuracy performed best, with an average score of 6.94 points, followed by source diversity, with an average score of 5.62 points, while analytical depth was relatively weak, with an average score of 6.59 points. Specifically, analytical depth showed significant individual differences,

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indicating that most students were deficient in in-depth analysis. It is worth noting that there is a moderate positive correlation between retrieval accuracy and source diversity, but both have a low correlation with analysis depth, indicating that high-level information processing capabilities need to be cultivated separately. The experimental results further show that there is a lack of critical analysis training in current teaching, especially in the integration of cross-source information and the deconstruction of complex data. Therefore, it is recommended to strengthen the analysis of interdisciplinary cases and the training of in-depth analysis frameworks in subsequent teaching to improve students' information processing and innovation capabilities.

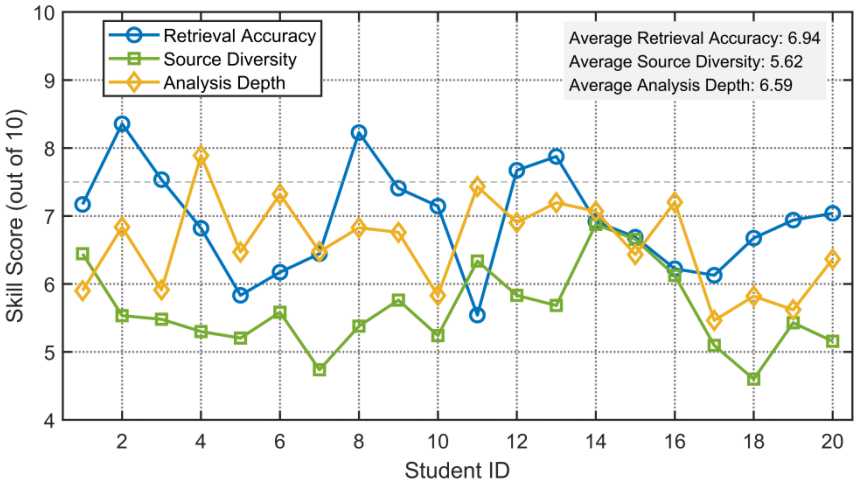

Figure 1 Information retrieval and analysis ability assessment

(2) Innovative project design and results display evaluation experiment

This experiment aims to compare the effects of traditional teaching methods and interactive teaching methods on students' cognitive load. The NASA-TLX scale was used to evaluate the cognitive load levels of the two groups of students at different time points (4th, 8th, and 12th lessons). The experimental data comes from 30 students, who were measured in traditional teaching classes and interactive teaching classes. The experiment focuses on analyzing the changing trend of cognitive load under different teaching methods, especially focusing on the cumulative effect of class time on cognitive load, as shown in Figure 2:

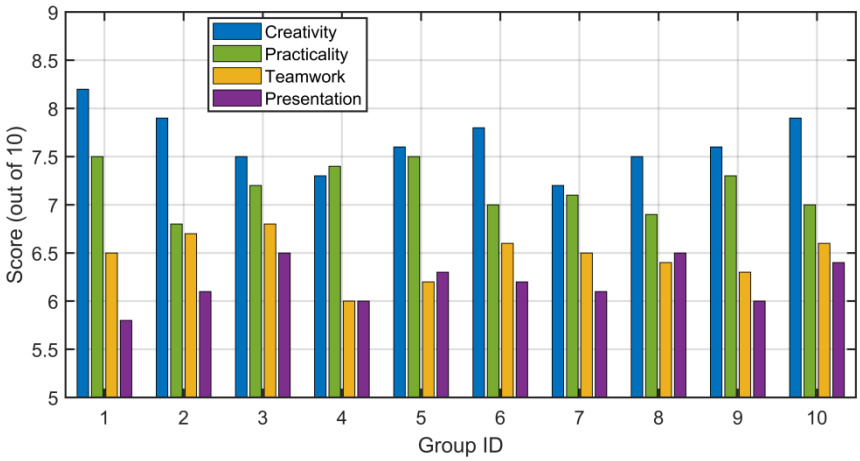

Figure 2 Evaluation of innovation project design and results display

The experimental results show that students have different performances in various dimensions of innovation projects, among which creativity has the highest score, with an average of 7.60 points, reflecting strong imagination and conception ability. The average score for practicality is 7.12 points, indicating that most projects have a certain degree of practical feasibility; the average score for teamwork is 6.57 points, which is relatively stable. The lowest score was for presentation ability, with an average of only 6.32 points, indicating that there is still room for improvement in project expression and results presentation. Overall, students have obvious advantages in innovative ideas, but still need to

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improve in results presentation and communication. It is recommended that in subsequent teaching, attention should be paid to the systematic integration of demonstration skills and expression training.

(3) Critical thinking and problem-solving ability assessment experiment

This experiment focuses on the cultivation of critical thinking and problem-solving skills, and sets four evaluation dimensions: problem identification, logical reasoning, depth of reflection, and rationality of strategy. Students need to analyze problems, discuss from multiple angles, and propose solutions based on designated cases. The scoring is completed independently by teachers based on unified standards. The experiment comprehensively reflects the actual performance of students in the high-order thinking process through quantitative data, providing a basic basis for subsequent teaching optimization, as shown in Figure 3:

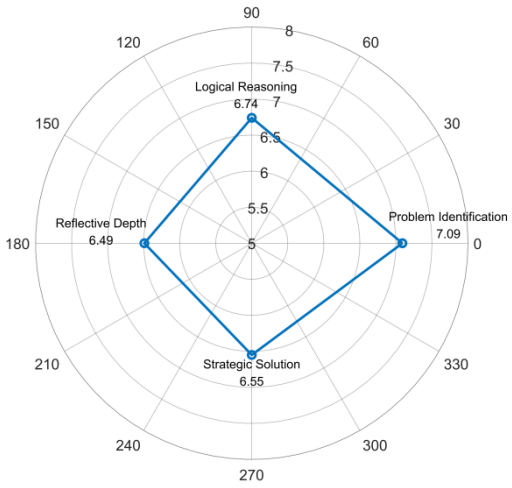

Figure 3 Evaluation of critical thinking and problem-solving skills

The experimental results show that there are certain differences in the performance of students in the four dimensions of critical thinking and problem-solving. Among them, the problem identification ability scored the highest, with an average of 7.09 points, indicating that students are more proficient in discovering and defining problems; the logical reasoning ability scored an average of 6.74 points, which is stable; The depth of reflection and rationality of strategy are relatively weak, with average scores of 6.49 and 6.55 respectively, reflecting that students still need to strengthen their in-depth analysis and solution formulation. Overall, students have certain basic critical thinking skills, but still need systematic training and guidance in high-level cognitive integration.

5. Conclusions

This study conducted a systematic exploration of the improvement of college students' information skills and innovative literacy in the context of the new liberal arts, constructed a training program centered on task-driven, collaborative inquiry, and project practice, and verified its applicability and effectiveness in actual teaching through multi-dimensional experiments. The results of the study show that the program can effectively promote the development of students' basic information capabilities, stimulate innovation awareness and practical ability, and has certain promotion value. However, it was also found during the experiment that high-level cognitive training is still weak, and some students have gaps in in-depth analysis and strategy formulation. In the future, the teaching process should be further improved, interdisciplinary integration and systematic training of critical thinking should be strengthened, and the cultivation of new liberal arts talents should be promoted to a more practice-oriented and ability-based path.

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