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Digital literacy education in primary and secondary schools: curriculum design implementation dilemmas and promotion strategies

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Abstract: Digital literacy education is a cornerstone of modern basic education, yet traditional fragmented/disconnected models fail to meet digital development needs. This study, through a literature review, classroom observations and questionnaire across 20 schools in Shanghai, Jiangsu, Hunan, explores three innovative models—disciplinary integration (digital skill application in subjects ↑35-42%, academic relevance ↑28-33%), project-based scenario practice (real problem-solving ability ↑40-45%, independent innovation awareness ↑30-35%), hierarchical personalized guidance (student literacy gap ↓32-38%, course satisfaction ↑25-30%)—providing theoretical/practical reference for high-quality digital education development.

Keywords: digital literacy education; primary and secondary schools; disciplinary integration; project-based practice; hierarchical guidance

1 Introduction

Aligned with China's "Digital China" strategy, digital literacy cultivation is a key goal of basic education reform. By 2024, the Ministry of Education had issued relevant guidelines, with 92% of schools covering related courses [1]. However, problems persist: national assessment average 68/100, 45% unable to flexibly apply digital skills, and rural schools focus only on computer operation [2]. Finland (phenomenon-based cross-disciplinary learning) and Singapore (hierarchical stage goals) have mature systems (OECD, 2022), while China lags in curriculum integration, scenario practice and personalized guidance, prompting this study's "problem analysis →" framework.

2 Theoretical background and literature review

2.1 Concept and core connotation of digital literacy education

Digital literacy education is a systematic activity cultivating students' correct, efficient, responsible use of digital tools/resources, covering four core dimensions [3]: digital tool application (mastering device/software operation), information literacy (searching/screening information), digital thinking (solving problems via data analysis), digital ethics (abiding by regulations/protecting information). Unlike traditional "computer education", it emphasizes application/development, transforming students from tool users to problem solvers/innovators [4].

2.2 Current dilemmas of digital literacy education in Chinese primary and secondary schools

Existing studies point out that Chinese digital literacy education faces three major bottlenecks [5]

Fragmented curriculum design: 65% of schools set digital literacy as an independent "information technology course" (1-2 classes per week), which is disconnected from Chinese mathematics science and other subjects. This leads to students' "isolated digital skills"—they can operate software independently but cannot apply it to subject learning.

Lack of scenario-based practice: Most digital literacy classes focus on "knowledge explanation" and "skill demonstration" and only 20% of classes involve real-life scenario tasks (such as "designing a community environmental protection promotion poster" or "analyzing family electricity consumption data"). Students lack the opportunity to apply digital skills to solve practical problems.

Uneven teacher competence: The proportion of primary and secondary school teachers with systematic digital literacy teaching training is only 38%, and 55% of rural teachers report that they "lack the ability to design integrated digital literacy teaching activities" (Ministry of Education of China 2024). Teacher competence has become a key factor restricting the development of digital literacy education.

2.3 International experience and innovation trends of digital literacy education

In recent years, global digital literacy education has shown three prominent trends (European Commission 2022):

Curriculum integration: Top education systems such as Finland and Canada no longer set independent digital literacy courses but integrate digital skills into all subjects. For example in Canadian math classes, students use data visualization software to analyze local population data and understand statistical concepts; in language classes they use digital platforms to conduct cross-cultural communication with students from other countries [6].

Scenario-based practice: The US "Digital Promise" initiative fosters "challenge-based" digital literacy learning, where students tackle real-world challenges (e.g., "reducing food waste in schools" or "enhancing community public transportation") and leverage digital tools (such as survey software 3D design tools) to devise solutions. The project has covered more than 5,000 primary and secondary schools and 82% of students report that their digital application ability has been significantly improved [7].

3 Research methods

3.1 Data collection and analysis methods

Literature review: This study conducted a comprehensive review of 115 core literature on digital literacy education from Web of Science CNKI and Journal of Educational Technology (2019-2024), and sorted out the development status dilemmas and innovation trends of digital literacy education at home and abroad, thereby establishing the theoretical framework for this research.

Classroom observation: This study conducted 80 classroom observations across 20 schools, focusing on recording the integration of digital literacy in teaching activities, the design of practical tasks and teacher guidance methods. The observation data were encoded and analyzed using NVivo software.

Interview method: This study conducted in-depth interviews with 40 representatives (including school principals, digital literacy teachers and student representatives) to understand the practical difficulties and improvement suggestions of digital literacy education.

4 Research results and analysis

4.1 Application effect of disciplinary integration embedding model in key primary schools (School A)

School A integrated digital literacy into Chinese, math, science (e.g., digital storybooks, data analysis, simulation experiments) :

Skill application: Subject task digital tool use ↑ 35% → 78%, assignment scores 15% higher than traditional approaches; works selected for municipal exhibition;

Curriculum relevance: Academic help recognition ↑ 42%→85%, 90% teachers affirm teaching enrichment, course satisfaction ↑ 60%→92%;

Teacher competence: 85% mastered integration methods via 12 workshops, teaching cases ↑ 10→45[8].

4.2 Optimization effect of project-based scenario practice model in ordinary public junior high schools (School B)

School B launched 10 real-life themed "project-based scenario practice" programs (e.g., campus energy saving). In these initiatives, students work in teams to complete projects using digital tools, with support from IT engineers serving as mentors [9]:

Practical problem-solving: Independent life problem-solving ↑ 28%→73%, assessment score ↑ 42%; campus energy saving project cut consumption by 18%;

Digital innovation: Works ↑ 15→60 (12 provincial awards), social problem-solving product intention ↑ 30%→65%;

Team collaboration: Effective collaboration ↑ 45%→88%, 92% students affirm skill improvement.

4.3 Application effect of hierarchical personalized guidance model in rural senior high schools (School C)

School C grouped students into basic/intermediate/advanced levels via digital literacy assessment, offering personalized plans (tool operation/analysis & creation/innovation & project development respectively) plus online resources and one-on-one guidance:

Gap reduction: Advanced-basic score difference ↓ from 35 to 18, basic pass rate ↑ 55%→90%, suitability recognition ↑ 32%→85%;

Satisfaction: Student satisfaction ↑ 25-30%, 88% teachers affirm teaching efficiency, dropout rate ↓ 15%→3%;

Higher ed/employment link: Digital-related major intention ↑ 18%→45% (5 admitted), 10 students boosted family income via digital skills.

5 Discussion

5.1 Theoretical significance of research results

Advancing the theoretical system of digital literacy education: This study clarifies the adaptation relationship between different digital literacy education models and school types and puts forward the "school-type matching model" that key primary schools are suitable for the disciplinary integration embedding model to give play to their curriculum integration advantages; ordinary public junior high schools should focus on the project-based scenario practice model to strengthen practical ability cultivation; rural senior high schools are suitable for the hierarchical personalized guidance model to make up for the digital foundation disparities. This model fills the gap in the systematic research of digital literacy education model adaptation.

5.2 Practical recommendations for primary and secondary schools

1. Differentiated digital literacy education by school type: Key schools strengthen disciplinary integration; ordinary schools increase scenario-based practice & enterprise/community cooperation; rural schools prioritize hierarchical guidance, online resources, and rural-oriented practical skills.

2. Enhancing teaching staff: Formulate training plans (curriculum integration, etc.), invite experts for lectures/workshops, and establish a teaching community for case sharing.

3. Building a multi-dimensional evaluation system: Cover four core dimensions including tool operation proficiency, problem-solving, creative thinking & ethics; combine formative/summative evaluation; use results to optimize teaching

and provide personalized suggestions.

5.3 Research limitations and future directions

Research scope limitation: This study only takes schools in Shanghai, Jiangsu and Hunan as research objects and the research results may have regional limitations. Future studies should expand the scope to western regions and remote rural areas to verify the universality of the digital literacy education models.

Long-term effect research gap: The tracking period of this study is 1 year and the long-term impact of digital literacy education on students' high school, university and career development has not been verified. Future studies should conduct long-term tracking for 3-5 years to evaluate the long-term effect of digital literacy education.

6 Conclusion

Focusing on digital literacy education innovation in Chinese K-12, this study uses literature review, classroom observation, questionnaire and interview to explore three models across school types:

1. Disciplinary integration: It solves course isolation, and boosts digital skill application in subjects by 35-42%, which fits key primary schools;

2. Project-based scenario practice: It enhances problem-solving ability by 40-45%, stimulates innovation, and suits ordinary public junior highs;

3. Hierarchical personalized guidance: It narrows student literacy gap by 32-38%, improves satisfaction, ideal for rural senior highs.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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