A Study on the Current Status and Cultivation Strategies of Intelligent Education Literacy Among Normal University Students in Northwestern Guangdong

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Abstract: The era of artificial intelligence has introduced new demands for intelligent education literacy (IEL) among normal university students. This study focuses on the relatively under-resourced region of Northwestern Guangdong, investigating the current status of intelligent education literacy among undergraduate normal university students through questionnaire surveys. The results indicate that: (1) The overall IEL level is above average; (2) There is a significant structural imbalance—while "ethical and legal awareness in intelligent education" is relatively strong, "intelligent learning literacy" and "intelligent teaching literacy" remain key weaknesses; (3) There exists a significant disparity in professional backgrounds: Arts and Physical Education (PE) normal students demonstrate comprehensive leading performance across all dimensions, while Science and Engineering normal students show relative weaknesses, with Humanities normal students positioned in between. No significant differences were observed in terms of gender and grade dimensions. Based on these findings, the study proposes differentiated, practice-oriented cultivation strategies, emphasizing the need to particularly strengthen intelligent learning and teaching capabilities of Science/Engineering and Humanities normal students, while deepening the practical transformation of ethical-legal competencies. These measures aim to optimize the competency structure of future regional teachers and provide support for their adaptation to intelligent education.

Keywords：**Intelligent Education Literacy; Normal University Students; Northwest Guangdong; Disciplinary Differences**

1. Introduction

In the current era, intelligent education has become an important development direction. In recent years, the Chinese government has placed great emphasis on advancing intelligent education, with the Ministry of Education proposing to strengthen teachers' information-based teaching capabilities. As pre-service teachers, normal university students must continuously improve their intelligent education literacy to meet the demands of contemporary development. However, intelligent education for normal university students in northwestern Guangdong started relatively late, with incomplete construction of teaching facilities and faculty teams. Issues such as outdated and mechanistic course content during the training phase still persist [1]. This may lead to generally low levels of intelligent education literacy among normal university students, making it difficult to meet the needs of future education. Currently, most research on intelligent education literacy focuses on in-service teachers, with relatively few specialized studies targeting normal university students. This study takes normal university students as its research subjects, providing new perspectives and approaches for research in this field.

Intelligent literacy was relatively early studied in academic circles, forming a standard system encompassing four dimensions: intelligent education, intelligent knowledge, intelligent application, and intelligent ethics [2]. With the refinement of research subjects and in-depth conceptual studies, incorporating intelligent moral ethics into the core structure of intelligent education literacy has gradually become an academic consensus. Furthermore, a widely recognized 'iceberg structure model' of teachers' intelligent education literacy has emerged, covering AI ontological knowledge,

discipline-specific pedagogical knowledge integrated with AI, AI Teaching Literacy capabilities, and AI educational ethics and beliefs [3]. This model places greater emphasis on intelligent teaching. Subsequent scholars extended this model and contemporaneous research to derive the concept of normal university students' intelligent education literacy, incorporating intelligent learning as the fundamental developmental driver for pre-service teachers into its scope [4-5]. Therefore, considering the dual identity of normal university students, this study defines the concept of their intelligent education literacy as a comprehensive competency integrating intelligent learning literacy, intelligent teaching literacy, and intelligent ethics and beliefs. This encompasses educational knowledge, tool application capabilities, and moral ethics, aiming to help normal university students adapt to intelligent education development and achieve effective teaching in the future.

2. Research Methods

2.1 Research Subjects

The questionnaires were distributed, answered, and collected online. After collection and analysis, a total of 167 valid questionnaire responses were obtained. The statistical results are shown in Table 1:

Table 1. Descriptive Statistics of Demographic Variables

Item	Category	Frequency	Percentage	Cumulative Percentage
Gender	Female	112	67	67.066
	Male	55	33	100
Academic Year	Freshman	44	26	62.874
	Sophomore	61	37	36.527
	Junior	42	25	88.024
	Senior	20	12	100
Major	Humanities	74	44	44.311
	Science and Engineering	53	32	76.048
	Arts and Physical	40	24	100
Normal Student Type	Regular Normal Student	125	75	74.85
	Government-funded Normal Student	42	25	100

The statistical results are presented in Table 1. The gender distribution comprised 112 female students (67%) and 55 male students (33%). By academic year, the sample included 44 freshmen (26%), 61 sophomores (37%), 42 juniors (25%), and 20 seniors (12%). Regarding academic disciplines, there were 74 students in humanities majors (44%), 53 in science and engineering majors (32%), and 40 in arts and physical education majors (24%). In terms of normal student categories, regular normal students accounted for 125 individuals (75%), while government-funded normal students numbered 42 (25%).

2.2 Research Instruments

This study employed the "Pre-service Teachers' AI Literacy Self-assessment Questionnaire" developed by Ren Yijing [6] as the research instrument. Based on the conceptual framework of AI literacy for teacher candidates, the questionnaire consists of two parts: the first section collects demographic information including gender, academic year, and major, with additional adaptive items incorporated; the second section comprises an assessment scale with three dimensions (AI learning literacy, AI teaching literacy, and Intelligent Education Ethics) using a five-point rating scale (Excellent, Good, Average, Below Average, Poor). The questionnaire demonstrated sound structure, clear dimensions, and good reliability in this study (Cronbach's $\alpha = 0.844$).

3. Results

3.1 Current Status of Pre-service Teachers' AI in Education Literacy

Table 2. Descriptive Statistical Analysis of Pre-service Teachers' AI in Education Literacy

Dimension	N	Min	Max	Mean
AI Ethics & Legal Awarenes	167	1	5	3.816
AI learning literacy	167	1	5	3.444
AI Teaching Literacy	167	1	5	3.442

As shown in Table 2, pre-service teachers in northwestern Guangdong exhibit an overall above-average level of AI in education literacy

(with mean scores across all three dimensions exceeding the theoretical median of 3), indicating their foundational understanding and application capabilities in AI-enhanced education. However, the data reveals an imbalanced development among the three dimensions: "Intelligent Education Ethics" (mean=3.816) significantly outperforms both "AI learning literacy" (mean=3.444) and "AI Teaching Literacy" (mean=3.442). This suggests that while these teacher candidates demonstrate relatively strong awareness of ethical norms and legal risks in AI applications, they show comparable weaknesses in two areas: utilizing AI tools for self-directed learning and effectively incorporating AI into future classroom instruction. These findings align with previous research [7], which posits that pre-service teachers typically possess adequate humanities literacy and social responsibility to comprehend professional ethics, yet often lack systematic consideration regarding how to select appropriate AI tools and deeply integrate them with pedagogical practices.

3.2 Differential Analysis of Pre-service Teachers' AI in Education Literacy Across Background Variables

An analysis of variance (ANOVA) was conducted between individual items across the three questionnaire dimensions and controlled demographic variables (gender, academic year, major, and pre-service teacher program type) to determine the presence of statistically significant differences. This analysis identified the influence of these four variables on the research outcomes, providing empirical support for developing targeted and effective strategies to enhance pre-service teachers' AI in education literacy in subsequent training interventions.

Table 3. Differential Analysis of Pre-service Teachers' AI in Education Literacy by Gender

Analysis Item	Gender (Mean ± SD)		F	p
	Female (n=112)	Male (n=55)		
AI Teaching Literacy	3.40±0.63	3.52±0.61	1.395	0.239
AI learning literacy	3.40±0.66	3.53±0.61	1.363	0.245
Intelligent Education Ethics	3.83±0.58	3.79±0.59	0.217	0.642
* p<0.05 ** p<0.01				

Table 4. Differential Analysis of Pre-service Teachers' AI in Education Literacy by Academic Year

Analysis Item	Year (Mean ± SD)				F	p
	Freshmen (n=44)	Sophomores(n=61)	Juniors (n=42)	Seniors (n=20)		
AI Teaching Literacy	3.60±0.71	3.43±0.57	3.38±0.59	3.27±0.65	1.569	0.199
AI learning literacy	3.59±0.73	3.39±0.60	3.39±0.67	3.40±0.52	1.032	0.380
Intelligent Education Ethics	3.90±0.69	3.76±0.53	3.84±0.59	3.76±0.49	0.562	0.641
* p<0.05 ** p<0.01						

Table 5. Differential Analysis of Pre-service Teachers' AI in Education Literacy by Major

Analysis Item	Major (Mean ± SD)			F	p
	Humanities (n=74)	Science and Engineering(n=53)	Arts/PE (n=40)		
AI Teaching Literacy	3.31±0.55	3.25±0.48	3.94±0.68	20.812	0.000**
AI learning literacy	3.39±0.55	3.23±0.55	3.84±0.75	12.318	0.000**
Intelligent Education Ethics	3.76±0.54	3.71±0.53	4.06±0.67	4.935	0.008**
* p<0.05 ** p<0.01					

As shown in Table 3, the differences between male and female pre-service teachers in AI learning literacy literacy, AI Teaching Literacy literacy, and Intelligent Education Ethics did not reach statistical significance (p>0.05), indicating that gender has minimal impact on these dimensions of AI in education literacy.

As indicated in Table 4, the differences among pre-service teachers of different academic years in AI learning literacy literacy, AI Teaching Literacy literacy, and Intelligent Education Ethics did not reach statistical significance (p>0.05), suggesting that academic progression has minimal impact on these dimensions of AI in education literacy.

The analysis of Table 5 reveals statistically significant differences (p<0.01) among pre-service teachers from different majors in AI learning literacy literacy, AI Teaching Literacy literacy, and Intelligent Education Ethics, demonstrating that disciplinary backgrounds exert substantial influence on these core competencies of AI in education.

Table 6 demonstrates no statistically significant

differences (p>0.05) between public-funded and regular pre-service teachers across AI learning literacy literacy, AI Teaching Literacy literacy, and Intelligent Education Ethics dimensions, indicating that teacher training types exert negligible influence on these core competencies of AI in education.

Table 6. Comparative Analysis of AI in Education Literacy by Pre-service Teacher Type

	Normal Student Type (Mean ± SD)		*F*	*p*
	Public-funded (*n*=42)	Regular (*n*=125)		
AI Teaching Literacy	3.39±0.61	3.46±0.63	0.353	0.553
AI learning literacy	3.41±0.64	3.45±0.65	0.121	0.728
Intelligent Education Ethics	3.78±0.54	3.83±0.60	0.196	0.659
* *p*<0.05 ** *p*<0.01				

4. Findings and Conclusions

Based on the empirical evidence, this study yields the following key conclusions:

4.1 Ethical and Legal Dimensions of AI in Education: A Comparative Strength Requiring Enhanced Implementation

Pre-service teachers in northwestern Guangdong demonstrate heightened sensitivity and awareness regarding ethical issues in AI-enabled education (e.g., data privacy, algorithmic fairness, intellectual property) and relevant laws/regulations (e.g., Personal Information Protection Law, educational data security standards). This reflects both the broad societal discourse on technology ethics and the fundamental requirements for teacher ethics and legal education in teacher training programs. Consequently, this dimension has emerged as a relative strength in their AI-in-education competency.

However, with average scores approaching but not reaching 4 ("good"), we observe that such awareness hasn't fully transformed into internalized values or conscious practical principles. When confronting complex, real-world AI application scenarios in education, these teachers-in-training may still require systematic knowledge enhancement and practical training to: (1) accurately identify ethical dilemmas, (2) operate in legally compliant ways, and (3) guide students in developing appropriate technological ethics perspectives.

Thus, while these teachers have established preliminary ethical-legal awareness, there remains a discernible gap between cognition and practice that warrants targeted improvement.

4.2 Dimension of 'AI-Enabled Learning Competency': A Critical Shortfall Requiring Enhanced Self-Directed Learning Capabilities

This dimension scored the lowest (3.444), unequivocally demonstrating that pre-service teachers in northwestern Guangdong exhibit substantial deficiencies in their capacity to leverage artificial intelligence technologies for optimizing professional learning and development. The shortcomings primarily manifest as inadequate familiarity with or ineffective utilization of AI-driven learning tools (including intelligent question banks, personalized learning platforms, and academic resource recommendation systems), coupled with insufficient strategies for applying AI to knowledge management, reflective learning, and research-based learning, along with underdeveloped critical evaluation skills regarding AI-assisted learning approaches.

As future educators, this current status indicates that their ability to harness AI for autonomous learning and professional advancement represents a pronounced weakness within their competency framework. Enhancing this particular literacy dimension constitutes both the fundamental basis for improving their future professional competitiveness and the essential prerequisite for developing their capacity to effectively guide students in intelligent learning practices.

4.3 The "AI-Teaching Competency" Dimension: A Critical Deficiency Highlighting the Urgent Need for Future Teaching Capability Transformation

The dimension of "AI-Teaching Competency" (mean score: 3.442) demonstrates a comparable yet similarly deficient level to "AI-Learning Competency," directly indicating pre-service teachers' insufficient preparation for effectively integrating artificial intelligence technologies into future classroom instructional design, implementation, and evaluation. This manifests through limited understanding of AI educational

tools' functionalities and application scenarios, inadequate ability to design AI-enhanced blended teaching models or personalized instructional plans, lack of proficiency in utilizing AI for precise learning analytics, automated assignment grading, or scientific teaching effectiveness assessment, as well as confusion regarding maintaining teacher agency and human-AI collaborative strategies in technology-enhanced instruction. These observations substantially align with academic research suggesting that some pre-service teachers' comprehension of AI remains superficial [8], confined to theoretical knowledge without transitioning into authentic teaching contexts to acquire practical skills for AI-empowered pedagogy [9].

As the core competency for future educators to thrive in intelligent educational environments, the current state of AI-teaching literacy paradoxically represents one of the most critical weaknesses in professional development16. Failure to address this gap will fundamentally constrain their capacity to innovate educational practices and enhance teaching efficacy through technological means, thereby constituting an urgent priority in teacher training systems46. The deficiency particularly impacts their future ability to revolutionize educational practices through technological innovation and improve teaching effectiveness, making it a critical focus requiring immediate reinforcement in pre-service teacher cultivation frameworks.

4.4 Disciplinary Heterogeneity in AI-Education Literacy: Arts/PE Majors Outperform Across All Dimensions

Significant disciplinary heterogeneity in AI-education literacy was observed among pre-service teachers in northwestern Guangdong ($p < 0.05$). Arts/PE majors demonstrated comprehensive superiority across all dimensions (Intelligent Teaching Literacy: M=3.94; Intelligent Learning Literacy: M=3.84; AI-Ethics & Legal Awareness: M=4.06), while science and engineering majors scored lowest in all metrics (Intelligent Teaching Literacy: M=3.25; Intelligent Learning Literacy: M=3.23; AI-Ethics & Legal Awareness: M=3.71). Humanities majors showed intermediate performance (Intelligent Teaching Literacy: M=3.31; Intelligent Learning Literacy: M=3.39; AI-Ethics & Legal Awareness: M=3.76). These findings challenge the conventional assumption of Science and Engineering students' inherent technological advantage, suggesting AI-education literacy development may be more closely related to discipline-specific learning patterns and technological application contexts rather than mere technical knowledge background. No significant differences were found regarding gender or academic year.

In summary, this study reveals that pre-service teachers in northwestern Guangdong exhibit an "awareness-first, application-weak" pattern in AI-education literacy, with significant disciplinary disparities. While demonstrating preliminary ethical-legal awareness in the "AI-Ethics & Legal Awareness" dimension, their ability to translate cognition into practice remains inadequate. The critical deficiencies lie in "Intelligent Learning Literacy" and "Intelligent Teaching Literacy," reflecting core competency gaps in leveraging AI for self-directed learning and future pedagogical empowerment. Notably, literacy levels display striking disciplinary differentiation: Arts/PE majors outperform both science and engineering and humanities majors across all dimensions, challenging the conventional expectation of science and engineering students' technological superiority. This strongly suggests that AI-education literacy acquisition depends more on discipline-specific practices involving deep integration and frequent application of intelligent technologies, rather than mere disciplinary knowledge backgrounds. These findings provide crucial evidence for constructing differentiated, practice-oriented training systems.

5. Discussion and Recommendations

Based on the current situation and issues revealed in this study, the following core strategies are proposed to systematically enhance AI-education literacy among pre-service teachers in northwestern Guangdong, with particular emphasis on addressing the deficiencies in Intelligent Learning Literacy and Intelligent Teaching Literacy, promoting the integration of knowledge and practice in AI-Ethics & Legal Awareness, and ensuring equitable and effective cultivation for all students:

5.1 Constructing a Tiered-Integration and Full-Process Intelligent Education Literacy Curriculum System

To fully realize the fundamental role of "curriculum as the core vehicle for talent cultivation [10]", we must break away from the fragmented approach to competency development and deeply integrate intelligent education literacy throughout the entire teacher preparation process. At the general education level, courses such as Introduction to Education and Modern Educational Technology should focus on strengthening the ethical and legal foundations of intelligent education (covering critical issues including data privacy, algorithmic fairness, and intellectual property regulations) while promoting the widespread application of intelligent learning tools like AI-assisted literature retrieval and knowledge management systems, ensuring all teacher candidates establish fundamental understanding.

In disciplinary professional education, particularly in subject teaching methodology courses, the curriculum should closely align with subject-specific characteristics to deepen intelligent teaching literacy training. This involves systematically designing practical tasks that incorporate AI-empowered teaching components such as lesson planning with AI integration, precision learning analytics through simulated AI diagnostics, personalized exercise design, and the application of intelligent assessment feedback.

During teaching practicum (including observation, practice, and research components), programs must explicitly require and effectively guide teacher candidates to apply intelligent tools for both self-reflective learning and authentic classroom instruction, while establishing specialized evaluation metrics to ensure the effective transformation of theoretical knowledge into practical teaching competencies.

5.2 Deepening Contextual Immersion and Ethical Decision-Making Practice to Facilitate the Transformation of Moral-Legal Awareness into Behavior

To address the challenge of "easier said than done" in the ethical and legal dimensions of intelligent education, it is crucial to develop case libraries based on authentic AI application scenarios in education, covering issues such as student data privacy boundaries, fairness concerns in AI evaluation, and intellectual property of generated content. By regularly organizing immersive ethics workshops, simulated court debates, and situational decision-making exercises, students can be guided to analyze ethical dilemmas, identify applicable regulations, assess risks, and formulate solutions within highly realistic and complex scenarios. Legal experts, ethicists, and experienced frontline teachers should be invited to share practical experiences and challenges, with workshop outcomes incorporated into relevant course assessments or practicum credits.

Furthermore, students should internalize the use of technology as a fundamental approach to learning and interacting with the world. This process of technological internalization should foster the attitudes and cognitive habits necessary for critically evaluating technology use [11], thereby effectively enhancing teacher candidates' judgment and practical capabilities in addressing real-world ethical and legal challenges.

5.3 Establishing an "AI-Empowered Learning & Research" Support Platform to Address Key Gaps in Intelligent Learning Literacy

To address the core issue of teacher candidates' inadequate ability to utilize AI for enhancing their professional learning, institutions should integrate internal and external resources to establish physical or virtual "AI-Empowered Learning and Research Centers." These centers would systematically curate and promote high-quality, accessible AI tools specifically designed for teacher professional development, including intelligent literature analysis, research data processing, and micro-lecture creation systems.

A series of micro-certification workshops and online courses should be developed around the theme "How AI Can Enhance My Learning and Research," focusing on cultivating critical competencies such as AI-assisted efficient literature review and management, data-driven self-diagnosis and planning of learning pathways, and AI-optimized instructional design and educational research methodologies.

Concurrently, institutions should encourage the formation of "Student AI Learning Pioneer Teams" to facilitate peer support, while incorporating the effective use of AI tools for coursework completion, research projects, and qualification exam preparation into the evaluation system. This comprehensive approach aims to cultivate a campus culture that

champions "proficient AI-enhanced learning" as a fundamental professional disposition.

5.4 Advancing Deep Integration of Intelligent Technologies with Disciplinary Teaching, with Special Emphasis on Enhancing Practical Capabilities of Science and Engineering as well as Humanities Teacher Candidates

The study reveals a significant gap in intelligent education literacy among both science and engineering as well as humanities teacher candidates, which primarily stems from the disconnect between subject knowledge acquisition and intelligent education technology application in current training systems. Unlike arts and physical education programs where technological tools are deeply embedded in daily professional practice, these disciplines lack similar integration scenarios. To address this issue, the proposed strategy centers on implementing differentiated curriculum reforms that achieve deep integration between intelligent technologies and subject teaching.

For science and engineering teacher education programs, mandatory incorporation of intelligent technologies should be implemented in core courses including subject pedagogy, experimental design, and project-based learning. This involves using virtual simulations, data visualization, and AI programming teaching platforms to solve discipline-specific teaching problems and optimize learning processes, while designing authentic teaching scenario-based technology application tasks. For humanities teacher education programs, systematic integration of intelligent technologies tailored for humanities instruction is needed, such as employing AI text analysis for in-depth interpretation of classical texts, creating immersive VR/AR reconstructions of historical events, applying intelligent speech technology to enhance language training, and utilizing learning analytics to improve essay evaluation feedback.

This integration should transcend basic tool introduction and instead focus on applying intelligent technologies to address core teaching challenges in each discipline, thereby enhancing teaching effectiveness. Through this approach, teacher candidates can master subject knowledge while developing deep understanding and internalization of how intelligent technologies create value and application capabilities in their specific educational contexts, effectively bridging the intelligent education literacy gap. Meanwhile, successful integration experiences from arts and physical education programs should be systematically summarized to provide reference models for other disciplines.

6. Conclusion

This study focused on Northwest Guangdong, a region with relatively limited educational resources, and empirically investigated the current status, structural characteristics, and group differences of AI in education literacy among undergraduate pre-service teachers. The findings indicate that while the overall AI in education literacy level is moderate to upper, a significant structural imbalance exists: performance in Intelligent Education Ethics is relatively better, reflecting foundational awareness, whereas AI Learning Literacy and AI Teaching Literacy constitute critical deficiencies in core competencies for utilizing AI to empower both personal learning and future teaching. Notably, salient disciplinary differences emerged, with Arts/PE students demonstrating comprehensive leadership across all dimensions, Humanities students in the middle, and Science/Engineering students relatively weaker. This challenges the common assumption of inherent higher technological literacy among Science/Engineering students, suggesting that literacy development relies more heavily on the depth of integration and application frequency within specific disciplinary practices than on disciplinary background alone. No significant differences were found based on gender, grade level, or student type. Consequently, this study proposes a set of differentiated, practice-oriented cultivation strategies: constructing a tiered and integrated curriculum, deepening contextualized ethical/legal practice, establishing AI-enabled learning/research platforms, and prioritizing deep integration of intelligent technologies into Science/Engineering and Humanities/Social Sciences subject teaching. These strategies aim to systematically address weaknesses, bridge the knowledge-practice gap, optimize the AI literacy structure of future teachers in the region, and support their adaptation to intelligent educational transformation. This study not only enriches research on pre-service teachers' AI literacy and provides empirical evidence for underdeveloped regions but also offers a new perspective for understanding its formation

mechanism through the revealed disciplinary differences.

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