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Exploring the Development of Undergraduates' Academic Literacy and Its Influencing Factors Based on Social Cognitive Theory

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Abstract: Academic literacy is a significant indicator to measure the academic development level of undergraduates and the construction of higher education in China. In order to analyze the current situation of the undergraduates' academic literacy development and relevant key influencing factors, this study constructed a corresponding research model on influencing factors of academic literacy based on Social Cognitive Theory. To verify the proposed model and hypotheses, the study was conducted among undergraduate students of Beijing A University. This study found that: (1) The digital literacy and social network had significant positive impacts on academic literacy from the behavioral and environmental levels, respectively; (2) There was a significant positive mutual influence between digital literacy and social network; (3) Digital literacy and social network jointly formed two mediating paths affecting academic literacy. To further enhance the academic literacy of undergraduate students, the study offers the following suggestions for the cultivation of academic ability: (1) Great importance should be attached to the design of research processes; (2) The deep integration of digital literacy and academic literacy should be promoted; (3) A diversified and dynamic academic evaluation system should be improved to encourage students' all-round development.

Keywords: academic literacy, digital literacy, social network, social cognitive theory, undergraduate students

INTRODUCTION

Research Background

In 2025, China reaffirmed the imperative to continuously strengthen the comprehensive capacity of higher education and enhance talent cultivation. As a comprehensive representation of the skills required for academic development [1], academic literacy can empower undergraduates to assume the multifaceted educational role of both learners and creative researchers [2]. Consequently, as one of the core constituencies of higher education, the cultivation of academic literacy among undergraduates holds significant importance for both their personal development and the advancement of higher education. With the continuous development of generative artificial intelligence, the influence of digital literacy in academic research is growing. Digital literacy emphasizes the use of existing knowledge to achieve knowledge connection and knowledge production [3], bringing new changes to scientific research paradigms and modes of academic exchange. It has become an indispensable factor in the cultivation of academic literacy. Furthermore, as the socialization of academic literacy serves as a crucial process through which students acquire academic knowledge and expand their social relationships [4], the support of social networks is also vital to the cultivation of undergraduates' academic literacy.

Consequently, taking into account the behavioral nature of digital literacy and the contextual nature of social networks, this study establishes a research model for academic literacy based on Social Cognitive Theory. Based on empirical research conducted on undergraduates at a university in Beijing, this study explores the undergraduates' developmental profile of academic literacy. Besides, the relationship between academic literacy, digital literacy and social networks is further clarified, providing more targeted strategies and practical pathways for the cultivation of academic literacy among undergraduates.

Research Questions

As of the time of this study, a search on CNKI using the term 'academic literacy' yielded over 1,000 core articles from both China and abroad. The ratio of articles examining postgraduate academic literacy to those examining undergraduate academic literacy stood at 7:1. Much of the relevant research has focused on postgraduate students or specific disciplinary fields, including academic English for postgraduates and scholarly writing [5]. This indicates that, although the importance of cultivating academic literacy has been recognized in higher education, research focusing primarily on undergraduates remains relatively scarce. Therefore, to investigate the development of academic literacy among undergraduates, this study proposes the following research questions:

(1) What is the essence of academic literacy? What dimensions are included in the assessment of undergraduate academic literacy?

(2) What is the current state of undergraduates' academic literacy? In what aspects is this reflected?

(3) How do digital literacy and social networks influence undergraduates' academic literacy, and what are the mechanisms of this influence?

CORE CONCEPTS AND THEORETICAL FRAMEWORK

Academic Literacy

The Conceptual Definition of Academic Literacy

As there is still no consensus on the relationship between literacy and knowledge [8], different scholars currently hold varying interpretations of the connotations of academic literacy. Timothy et al. argue that academic literacy emphasizes the development of individuals' higher-order thinking skills and advanced language skills rather than basic literacy skills [9]. Some researchers contend that academic literacy should be an organic integration of knowledge, abilities, thinking and attitudes within an academic research context, emphasizing its comprehensive and specialized characteristics [10].

With regard to the specific components of academic literacy, Mary and Brian were the first to propose a three-tiered framework for postgraduate academic literacy comprising learning ability, academic socialization and academic literacy, which they expanded and refined in 2006 [11][12]. Subsequently, Chinese scholars including Wang Lizhen proposed a framework comprising academic awareness, academic knowledge, academic ability and academic ethics [13]. Sun Qingyang found that observational skills, self-perception abilities,

and the development of literacy achieved through the interaction with socio-cultural contexts are key components of the academic literacy in the English discipline [14]. Xu Ling et al., however, argue that self-regulation and development capabilities, research knowledge and skills, scientific cognitive abilities, and research qualities constitute core elements in the formation of postgraduate academic literacy [2].

Research Dimensions of Academic Literacy

Undergraduate education forms the foundation for specialized further education at the postgraduate level [11], and the cultivation of academic literacy shares commonalities between undergraduate and postgraduate stages. Therefore, it is both reasonable and of research significance to construct a framework for undergraduate academic literacy by extrapolating from the composition of postgraduate academic literacy. Through an analysis and comparison of the views of various scholars, this study concludes that the perspective put forward by Wang Lizhen et al. comprehensively characterizes the connotations of academic literacy, as detailed in Table 1.

Table 1: The Essence and Dimensions of Academic Literacy

Concept	Connotation	Constituent Elements
Academic Awareness	Individuals' conscious and rational response to academic research activities and their sensitivity to academic information, which serves as the intrinsic driving force for scientific exploration and is an indispensable factor in promoting autonomous learning, independent thinking and innovation	-
Academic Knowledge	A system of specialized knowledge formed through mental processing during the systematic study of professional knowledge and the academic research process	Methodological Knowledge
		General Scientific and Cultural Knowledge
		Disciplinary Knowledge
Academic Competence	The relevant abilities and qualities essential for engaging in academic research	Ability of Academic Innovation
		Ability of Professional Selection and Judgment
		Ability of Academic Resource Acquisition
		Ability of Research Process Design
		Ability of Academic Paper Writing
Academic Ethics	The sum of the values and academic norms widely recognized in the field of academic research and commonly observed by academic researchers	-

Based on the academic literacy's theoretical framework proposed by Wang Lizhen et al., this study categorizes undergraduate academic literacy into four dimensions, including academic awareness, academic knowledge, academic competence and academic ethics. To ensure that the dimensions of academic literacy are more closely aligned with the theme of this study, the specific components of academic competence have been adjusted as follows:

(1) Resource acquisition capability: emphasizing the acquisition of both knowledge resources and environmental resources [15];

(2) Research process design ability: including the design of research objectives, research processes and research methods;

(3) Academic rigor: the basic standards that academic practitioners should adhere to when conducting academic activities [16].

The framework for undergraduate academic literacy adopted in this study is illustrated in Figure 1.

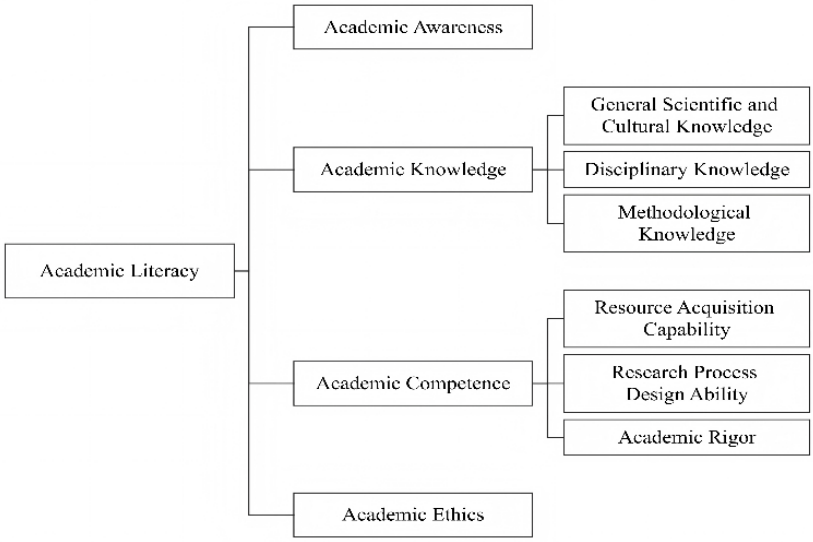

Figure 1: Framework for Undergraduate Academic Literacy

Digital Literacy

In 1997, Paul formally introduced the term 'digital literacy', defining it as the ability to retrieve information online, understand the implications behind links, and possess critical thinking and integration skills [17]. Subsequently, a conceptual framework for digital literacy was proposed, comprising five key elements: visual literacy, re-creation literacy, branching literacy, information literacy and emotional literacy [18]. Since then, the scope of digital literacy has continued to be expanded and enriched. In 2013, the European Union published *DigComp: A Framework for Developing and Understanding Digital Competence in Europe* [19] and launched *DigComp 3.0* in 2025 [20], providing a reference for the digital literacy education in the context of emerging technologies. In 2021, China issued an action plan for enhancing digital literacy and skills, defining a concept of digital literacy more suited to China's national conditions. The need to improve the digital talent cultivation system, the development of digital literacy skills and digital supply was emphasized [21].

Some scholars have found that digital literacy has a positive impact on researchers' research output [22]. Indah et al. have also demonstrated that there is a significant correlation between students' digital literacy and their research capabilities [23]. As the digital transformation of education deepens, it is evident that digital literacy has become a key factor influencing academic literacy. Therefore, this study establishes a digital literacy framework based on the content of the EU DigComp 3.0, comprising the components of information data literacy, communication and collaboration, digital content creation, and

problem solving, in order to investigate the relationship between digital literacy and academic literacy among undergraduates.

Social Network

The concept of social network was first proposed by Radcliffe-Brown and subsequently developed into a theory encompassing all formal and informal, direct and indirect interpersonal relationships [24]. From the direct analysis and depiction of social structures to the introduction of the structural hole theory, social network has gradually become an important research paradigm for interpersonal structures and relationship [25]. Social network research is often conducted using either self-centered or whole-network approaches based on core indicators provided by social network analysis, such as strength, density, centrality, connectivity and distance [26][27]. Depending on the chosen research approach, the corresponding measurement indicators also vary. For example, Sun Dapeng et al. collected data based on four functional dimensions of social network to explore the role of social network, including information acquisition, reciprocal cooperation, structural support and resource acquisition [28]. Zheng Qiao et al. focused on the social network of school teaching and research organizations, using the proportion of roles, organizational activity and organizational dynamism as measurement indicators [29].

Focusing on the social network relevant to this study, it is a relational network comprising undergraduates, lecturers and academic organizations as different nodes, and the transmission of knowledge, information and academic resources as relationships, which dynamically influences the development of undergraduates' academic literacy [30]. Therefore, based on the views of Zhou Xing et al., and taking into account the structural characteristics of social network and the developmental needs of undergraduates' academic literacy, the social network in this study should encompass four dimensions: network centrality, network connection strength, network heterogeneity, and network dynamism [31].

Social Cognitive Theory

Social Cognitive Theory was first proposed by Bandura in 1987. He argued that behavior, the individual and the environment can constitute a stable and mutually supportive triadic interaction model [32]. As this theory emphasizes the dynamic interaction between these three subjects, it has been widely applied in educational research worldwide. Liu Zhenhai et al. explored pathways for the innovative development of ideological and political education in higher education institutions, focusing on students' ideological and political literacy, the ideological and political education environment, and the pathways for ideological and political education actions [33]. Meanwhile, Yu Yanhong investigated the influence mechanism of digital reading on college Chinese teaching from three dimensions: reinforcement of observational learning, enhancement of self-efficacy, and optimization of environmental interaction [34]. Shahzad et al. have similarly employed self-efficacy as one of the model dimensions to investigate the impact on academic performance [35]. In the field of higher education, some scholars have conducted research on psychotherapeutic interventions based on Social Cognitive Theory [36].

Social Cognitive Theory rejects the linear causal determinism often employed in traditional research, advocating instead for complex interactive relationships between factors [37]. In the development of undergraduates' academic literacy, individual students' academic literacy levels are jointly influenced by their own digital literacy and social network relationships. In light of this, Social Cognitive Theory, which emphasizes the interactivity of multiple factors, is highly compatible with this study.

RESEARCH DESIGN

Research Process

This study first conducted a literature review on the conceptual definitions of academic literacy, digital literacy and social network, and then identified the sub-dimensions appropriate for the research into undergraduate academic literacy. Subsequently, drawing on Social Cognitive Theory, a research model was constructed with data literacy and social network as the influencing factors of undergraduates' academic literacy development, and relevant hypotheses were proposed.

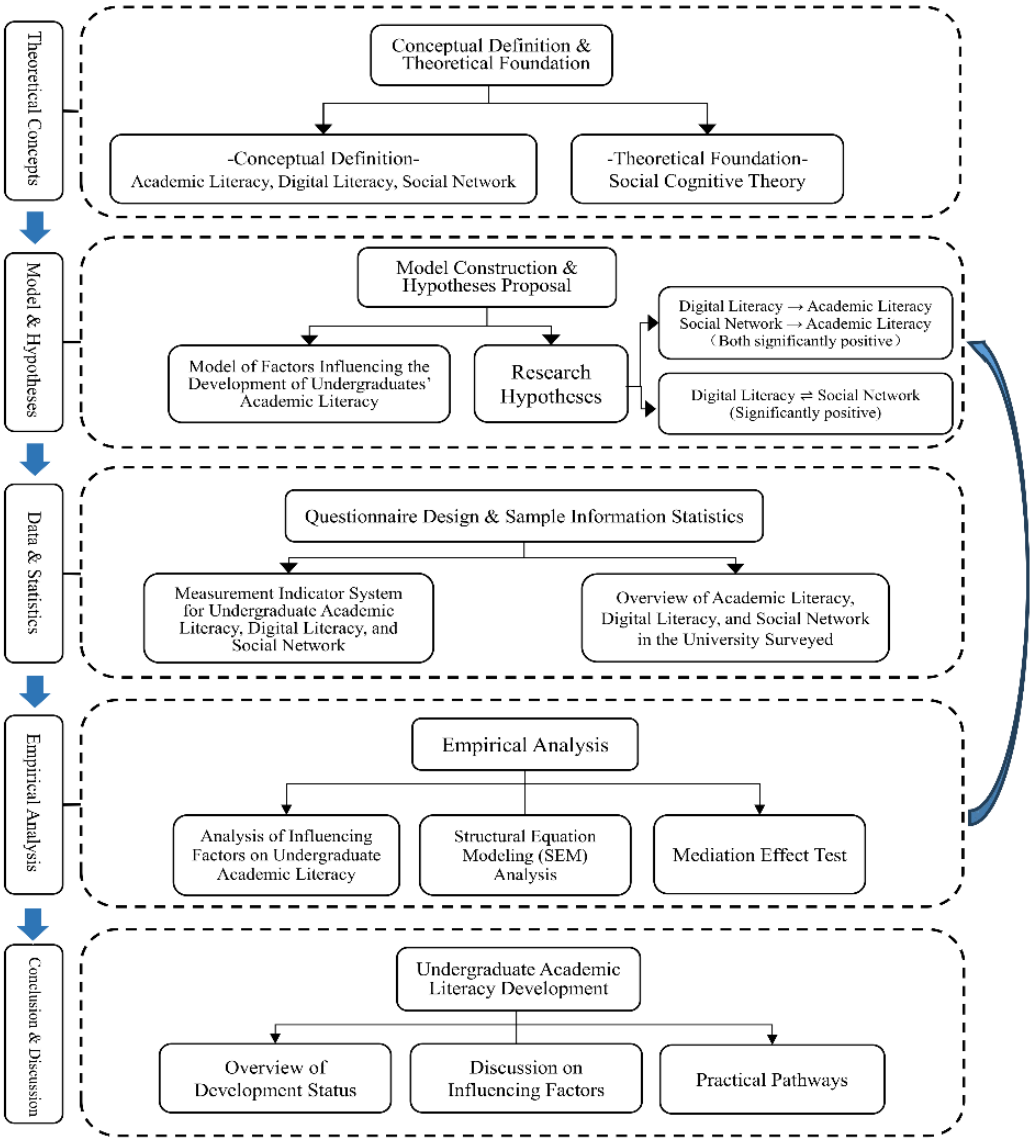

Figure 2: Research Flowchart

A questionnaire was then developed using established scales and expert advice, and its reliability was verified through a pilot study. Subsequently, using the collected data, the research team first mastered the overall situation of the three dimensions of digital literacy, social network and academic literacy. Building on this, regression and correlation analyses were employed to elucidate the fundamental relationships between digital literacy, social network, and undergraduates' academic literacy. Finally, structural equation modelling and mediating effect test were utilized to investigate the specific mechanisms underlying the mutual influence of digital literacy and social network, as well as their impact on the development of undergraduates' academic literacy. Ultimately, the research hypotheses were proved, and some practical suggestions were put forward according to the influence mechanism between digital literacy, social network and undergraduate academic literacy. The research flowchart is shown in Figure 2.

Research Methods

Questionnaire Method

This study utilizes the questionnaire survey to test the theoretical framework model proposed in the preceding section, examining the research hypotheses from a quantitative perspective. The study first identified the main dimensions of the questionnaire based on established scales from existing research. Subsequently, factor analysis was employed to verify the reliability and validity of the questionnaire and to screen the items, resulting in the final Questionnaire on the Development of Undergraduate Academic Competence and Its Influencing Factors.

Statistics Methods

This study employs data analysis methods such as correlation analysis, variance analysis (ANOVA), regression analysis and structural equation modelling to conduct mathematical and statistical analyses on the collected questionnaire data. This serves to validate the proposed theoretical model and hypotheses and explore the influence of digital literacy and social network on academic literacy.

Research Model and Hypotheses

Model Construction

Based on the interactivity of the individual, behavior and environment within Social Cognitive Theory, this study constructs a research framework comprising undergraduates' academic literacy (individual level), digital literacy (behavioral level) and social network (environmental level). It investigates the influence of undergraduates' digital literacy and social network on their academic literacy, as well as the mutual influence between the two. The specific model is shown in Figure 3.

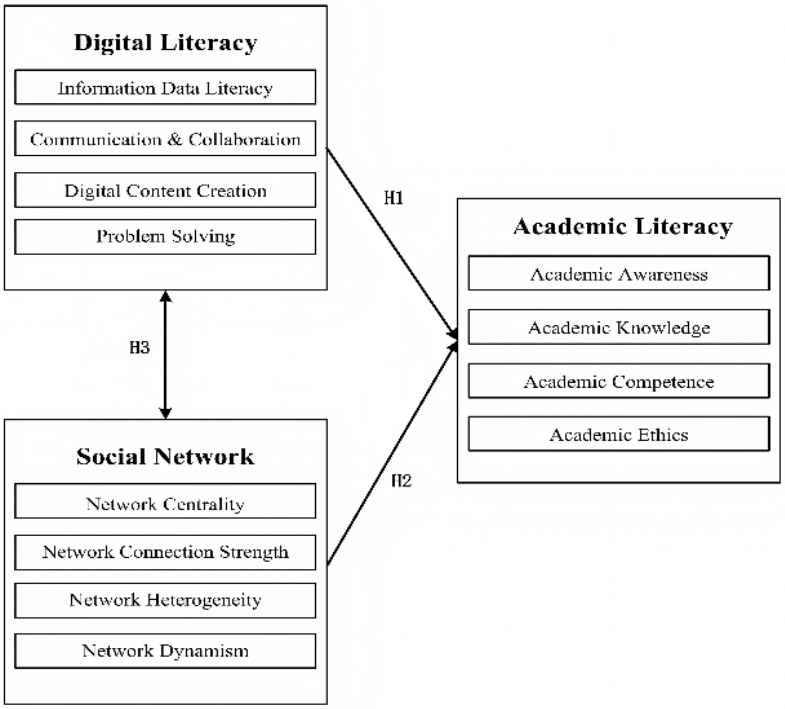

Figure 3: Model of Factors Influencing the Development of Academic Literacy

Research Hypotheses

The impact of digital literacy on academic literacy:

Students with high digital literacy possess stronger abilities in information retrieval, processing and analysis, which provides better support for academic activities. Meanwhile, students with high digital literacy are better able to communicate and collaborate with others via digital technologies, which facilitates the acquisition of valuable academic knowledge and opportunities. Students with high digital literacy have a stronger awareness of intellectual property rights and certain understanding of academic ethics. Furthermore, students with high digital literacy are better able to utilize digital technologies to create works related to their discipline and to solve professional problems. Based on the above analysis, this study proposes the following hypothesis.

- H1: Digital literacy has a significant positive influence on academic literacy

The influence of social network on academic literacy:

Academic research requires researchers to interact with others to obtain support in terms of knowledge, technology, funding and human resources. Specifically, individuals with high network centrality are more likely to access important information and resources within their networks and be entrusted with important tasks by teachers or sought out for help by peers. Therefore, those students are more likely to gain opportunities for academic exchange and research. In this process, the strength of their network relationships continues to increase, thereby further enhancing the student's own network centrality. Greater heterogeneity within social networks facilitates access to a wider range of valuable and non-redundant knowledge, perspectives and opportunities, whilst the dynamic nature of

students' social networks enables them to exchange information and resources conducive to their academic development with more individuals. Based on the above analysis, this study proposes the following relational hypothesis.

- H2: Social network has a significant positive influence on academic literacy

The influence relationship between digital literacy and social network

Students with high digital literacy possess stronger communication and collaboration skills, enabling them to express themselves more effectively through digital content, which can facilitate the establishment and maintenance of interpersonal relationships. Students with a broader social circle have access to a greater volume of digital information and data, which subtly contributes to the development of data collection and analysis skills. Thus, this study proposes the following relation hypothesis.

- H3: Digital literacy and social network have a significant positive reciprocal influence

Questionnaire Design

Questionnaire Development

On the basis of mature scales such as R-Comp scale [38] and DigComp framework supporting scale [39], this study preliminarily determined the main content of the questionnaire combined with expert advice. The main body of the questionnaire comprises four sections: undergraduates' basic personal information, their academic literacy, their digital literacy and their social network. An internationally standardized five-point Likert scale was adopted for each variable, with scores ranging from 1 (strongly disagree) to 5 (strongly agree). The research subjects for this study were all undergraduates of A University in Beijing. To ensure that participants could accurately understand each item, the team conducted a pilot survey prior to the full distribution of the questionnaire. Subsequently, based on the comprehension levels and linguistic habits of the undergraduate group, the obscure narrative in the questionnaire was revised, whilst omissions were supplemented. A final version of the questionnaire that was more practical and comprehensive was thus formed.

Questionnaire Reliability and Validity

To ensure the high reliability of the collected data, filtered reverse test items were added to certain questions during the questionnaire design phase. After the initial data collection, invalid questionnaire items were eliminated through cross-validation between the forward-scored questions and their reverse-scored counterparts. This study conducted a small-scale pre-survey using SoJump. A total of 127 questionnaires were collected. After the joint screening of the filter items and the test items, 116 valid questionnaires and 11 invalid questionnaires were obtained.

Reliability Analysis of the Data:

This study first conducted a reliability analysis on the 116 valid questionnaires, using Cronbach's α as the reliability evaluation metric. The analysis results are shown in Table 2.

According to the results, the Cronbach's α values for all three variables were greater than 0.8. Therefore, the scale used in this study exhibits high reliability, and a high degree of internal consistency among the measurement items.

Table 2: Reliability Test

Variable	Cronbach's α
Academic Literacy	0.943
Social Network	0.898
Digital Literacy	0.894

Validity Analysis of the Questionnaire:

Based on the data collected from the pre-survey, the factor analysis revealed that the KMO values for the three sets of variables—academic literacy, social network and digital literacy—were all greater than 0.7. The Bartlett's sphericity test was also highly significant (p-value < 0.001). As these data are multidimensional and share common characteristics, they are suitable for factor analysis, as shown in Table 3.

Table 3: KMO and Bartlett's Test

Variable	KMO Value	Bartlett's Test		
		X^2	Degrees of Freedom	P-value
Academic Literacy	0.819	280.102	6	0.000
Social Network	0.773	197.614	6	0.000
Digital Literacy	0.763	198.551	6	0.000

Principal component analysis was then used to conduct exploratory factor analysis on the three variables, yielding one factor with an eigenvalue greater than 1 for each. The factor loadings corresponding to the sub-dimensions of the three variables were all above 0.6, and the commonality coefficients were generally higher than 0.5. Therefore, the extracted common factors can effectively reflect their respective indicators. The cumulative variance explained by the twiddle factors for all three variables exceeded 50%, indicating that the information contained in the items can be effectively extracted. In summary, the questionnaire designed for this study demonstrates good validity.

EMPIRICAL ANALYSIS AND HYPOTHESIS TESTING

Descriptive Statistical Analysis

General Characteristics of the Survey Sample:

During the formal survey phase, a total of 234 valid questionnaires were collected. Analysis of the valid questionnaire data reveals the basic characteristics of the survey sample, as shown in Table 4 below. As can be seen from the table, the sample is evenly distributed in gender, with no obvious bias. At the same time, they are also involved in different grades and disciplines. Therefore, the overall distribution of the survey sample is objective and reasonable.

Table 4: Basic Characteristics of the Sample

Variable	Category	Number (units)	Proportion (%)
Gender	Female	122	52.1%
	Male	112	47.9%
Grade	2025 Cohort	83	35.5%
	2024 Cohort	73	31.2%
	2023 Cohort	37	15.8%
	2022 Cohort	41	17.5%
Subject Category	Literature & History	134	57.3%
	Science & Engineering	71	30.3%
	Economics & Management	24	10.3%
	Art & Sports	5	2.1%

Distribution of Digital Literacy and Its Sub-Dimensions

Descriptive statistical analysis of the scores of the digital literacy and its sub-dimensions revealed that the mean digital literacy score for undergraduates was 3.585. Among the four sub-dimensions of digital literacy, the mean score for the communication and collaboration dimension was the highest, whilst the score for the digital content creation dimension was the lowest, as shown in Table 5.

Table 5: Scores for Digital Literacy and Its Sub-Dimensions

Variable	Mean	Standard Deviation	Minimum	Maximum
Information Data Literacy	3.509	0.575	1.56	5.00
Communication & Collaboration	3.915	0.604	1.67	5.00
Digital Content Creation	3.462	0.710	1.00	5.00
Problem Solving	3.607	0.605	1.67	5.00
Digital Literacy (overall)	3.585	0.513	1.50	5.00

Distribution of Social Network and Its Sub-Dimensions

Descriptive statistical analysis of the scores of the social network and its sub-dimensions revealed that the mean score for the social network was 3.428. Among the sub-dimensions, the mean score for network connection strength was the highest, whilst the mean score for network centrality was the lowest, as shown in Table 6.

Table 6: Scores for Social Network and Its Sub-Dimensions

Variable	Mean	Standard Deviation	Minimum	Maximum
Network Centrality	3.235	0.655	1.00	5.00
Network Connection Strength	3.628	0.723	1.25	5.00
Network Heterogeneity	3.311	0.845	1.00	5.00
Network Dynamism	3.592	0.748	1.00	5.00
Social Network (Overall)	3.428	0.588	1.62	4.77

Analysis on the Development of Undergraduates' Academic Literacy

The questionnaire for measuring the academic literacy of undergraduates includes subjective questions measuring various dimensions of academic literacy, as well as objective questions reflecting students' academic performance. During the research process, the team took into account the answers to both objective and subjective questions to avoid the research conclusions being unduly influenced by the subjective cognitive biases of the research subjects.

Analysis of Academic Performance Measurement Data

The academic performance dimension was designed to reflect students' academic literacy levels based on objective indicators. Consequently, the survey focused on four items within this dimension: academic ranking, number of papers published, publications in core journals, and participation in academic activities. As of the survey date for this study, apart from 83 first-year students in 2025 cohort (accounting for 35.5%) who had not yet received an academic ranking, the number of students in the top 50 % is the largest, accounting for 16.7 %. The number of students ranked in the last 20 % is the least, accounting for only 3.8 %. Regarding paper publications, over 80% of students had not published any papers. Among those who had published, the majority had published only one paper, whilst only 6% had experience publishing in core journals as first or second author. Furthermore, regarding academic activities, the data indicated that nearly 40% of students had not participated in any academic activities.

Analysis of Self-assessment Data on Academic Literacy

Performance of Sub-Dimensions of Academic Literacy:

The four dimensions—academic awareness, academic knowledge, academic competence and academic ethics—were primarily assessed based on students' self-evaluation. The specific scores are shown in Table 7.

Table 7: Scores for Academic Literacy and Its Sub-Dimensions

Variable		Mean		Standard Deviation		Minimum		Maximum	
Academic Awareness		3.23		0.68		1.33		5.00	
Academic Knowledge		3.30		0.77		1.00		5.00	
Academic Competence	Resource Acquisition Capability	3.46	3.35	0.65	0.59	1.20	1.40	5.00	4.67
	Research Process Design Ability	3.44		0.66		1.00		5.00	
	Academic Rigor	3.14		0.72		1.40		4.80	
Academic Ethics		3.37		0.72		1.00		5.00	
Academic Literacy (Overall)		3.33		0.58		1.28		4.60	

As shown in Table 7, the mean score for undergraduates' overall academic literacy is 3.33. Among the four sub-dimensions of academic literacy, academic ethics had the

highest mean score of 3.37. Academic awareness had the lowest mean score of 3.23, whilst academic knowledge and academic competence were at an intermediate level. Among the three sub-dimensions under academic competence, resource acquisition capability had the highest mean score of 3.46, whilst academic rigor had the lowest mean score of 3.14.

Analysis of the relationship between academic literacy and its sub-dimensions:

Paired sample t test was conducted by pairing academic literacy with its sub-dimensions, with the results shown in Table 8. Notably, the sig-value for the comparison between academic literacy and academic awareness was less than 0.05, indicating a significant difference in scores between the two. The correlation coefficients between academic literacy and its four sub-dimensions were all greater than 0.7, indicating a strong correlation. This suggests that these four sub-dimensions have a significant influence on academic literacy. Furthermore, the correlation coefficient between academic competence and academic literacy was 0.968, which was higher than the other three correlation coefficients, indicating that academic competence has the greatest overall influence on academic literacy, followed by academic knowledge.

Table 8: Paired Sample T-test for Academic Literacy and Its Sub-Dimensions

Variable	t	df	Sig. (two-tailed)	Correlation Coefficient
Academic Literacy – Academic Awareness	3.383	233	0.001	0.759
Academic Literacy – Academic Knowledge	1.253	233	0.211	0.871
Academic Literacy – Academic Competence	-1.946	233	0.053	0.968
Academic Literacy – Academic Ethics	-1.661	233	0.098	0.796

Paired sample t test was conducted on academic competence and its sub-dimensions, with the results shown in Table 9.

The sig-values for academic competence and its three sub-dimensions were all less than 0.05, indicating that there were significant differences in scores between academic competence and its three sub-dimensions.

Among these, the influence of research process design ability on academic competence was the most pronounced.

Table 9: Paired Sample T-Tests for Academic Ability and Its Sub-Dimensions

Variable	t	df	Sig. (two-tailed)	Correlation Coefficient
Academic Competence – Resource Acquisition Capability	-5.042	233	0.000	0.864
Academic Competence – Research Process Design Ability	-4.770	233	0.000	0.884
Academic Competence – Academic Rigor	8.889	233	0.000	0.874

The Relationship between Academic Literacy and Academic Performance:

To ensure the findings of the survey on undergraduates' academic literacy are more objective, this study examined the relationship between students' academic literacy and their academic performance (academic ranking, number of papers published, publications in core journals, and participation in academic activities). The analysis revealed that the p-values for academic literacy and its sub-dimensions under the four indicators of academic performance were all less than 0.05, indicating that there were significant differences in self-assessment scores for academic literacy and its sub-dimensions among students among students with different rankings, different number of publications, with or without core journal papers, and different number of academic activities. The results indicate that students in the top 20% achieved the highest scores, whilst those in the bottom 50% had the lowest self-assessment scores. Students who had published papers or had papers in core journals scored higher, whereas those who had not published any papers scored the lowest and below the average. Students who participated in six or more academic activities scored the highest. The specific results are shown in Tables 10 to 13.

Table 10: Scores of Students with Different Rankings in Academic Literacy

Academic Ranking	Academic Literacy	Academic Awareness	Academic Knowledge	Academic Competence	Academic Ethics
Top 20%	3.684	3.596	3.782	3.679	3.667
Middle 30% (20% < rank ≤ 50%)	3.390	3.137	3.401	3.438	3.388
Back 50%	3.071	2.946	2.936	3.138	3.043
No Ranking	3.166	3.205	3.063	3.155	3.321
Overall Mean	3.33	3.23	3.30	3.35	3.37
Difference Effect Value F	11.711	7.279	13.466	10.919	5.236
Test Probability P	0.000	0.000	0.000	0.000	0.002

Table 11: Scores for The Total Number of Published Papers in Academic Literacy

Number of published papers	Academic Awareness	Academic Knowledge	Academic Competence	Academic Ethics	Academic Literacy
0	3.142	3.164	3.227	3.264	3.212
1	3.507	3.870	3.859	3.853	3.818
2	3.833	3.979	3.922	3.972	3.927
3	3.667	3.850	3.973	3.800	3.896
Difference Effect Value F	6.646	12.161	17.480	9.541	17.260
Test Probability P	0.000	0.000	0.000	0.000	0.000

Table 12: Scores of Students with or without Core Journal Papers in Academic Literacy

Core -journal Papers Publication Status	Academic Awareness	Academic Knowledge	Academic Competence	Academic Ethics	Academic Literacy
Already Had	4.024	4.179	4.219	4.167	4.183
Not Yet	3.177	3.240	3.291	3.324	3.273

Difference Effect Value F	21.939	21.515	37.235	19.596	37.119
Test Probability P	0.000	0.000	0.000	0.000	0.000

Table 13: Scores of The Number of Academic Activities in Academic Literacy

Frequency	Academic Awareness	Academic Knowledge	Academic Competence	Academic Ethics	Academic Literacy
0	3.004	2.968	3.107	3.141	3.076
1–2	3.196	3.205	3.258	3.411	3.261
3–5	3.444	3.667	3.704	3.667	3.662
≥6	4.167	4.313	4.383	4.250	4.330
Difference Effect Value F	6.297	8.818	9.464	4.064	10.111
Test Probability P	0.000	0.000	0.000	0.001	0.000

Analysis of Factors Influencing Undergraduates' Academic Literacy

The Impact of Digital Literacy and Social Network on Academic Literacy

Taking digital literacy and social network as independent variables and academic literacy as the dependent variable, a multiple linear regression analysis was conducted. A regression model was constructed to test whether hypotheses H1 and H2 were valid. The results are shown in Table 14. The adjusted R^2-value is 0.597, indicating that the model is of good quality and possesses a high explanatory power. The F test of the model showed that the P value of the F statistic was 0.000 (less than 0.05), confirming the model's significance. This suggests that at least one of the independent variables (digital literacy or social network) can significantly influence the dependent variable, academic literacy. The unstandardized coefficients for the two independent variables were 0.662 and 0.283 respectively. The according t-test results reveal a significant positive impact of digital literacy and social network on the undergraduates' academic literacy ($p < .001$), thus supporting hypotheses H1 and H2. Furthermore, the multicollinearity test of the model revealed that the VIF values for both independent variables were less than 5, indicating that there is no multicollinearity issue between the independent variables. Simultaneously, the model's DW value was 1.920, close to 2, suggesting that the model is free from autocorrelation. Consequently, the conclusions drawn from this regression model are accurate and reliable.

Table 14: Results of Regression Model Analysis (Dependent Variable: Academic Literacy)

Regression Model Summary						
R^2	Adjusted R^2	F		Significance of F		DW
0.600	0.597	173.521		0.000		1.920
Independent Variable	Unstandardized Coefficient	Standard Error	Standardized Coefficient	t	Sig.	VIF
Digital Literacy	0.662	0.056	0.583	11.869	0.000	1.397
Social Network	0.283	0.049	0.286	5.822	0.000	1.397

Effects of Digital Literacy and Social Network on Academic Literacy Sub-Dimensions

To investigate the specific effects of digital literacy and social network on the sub-dimensions of academic literacy, the study conducted pairwise correlation analyses between digital literacy and each sub-dimension of academic literacy, as well as between social network and these sub-dimensions. Correlation tests were conducted between digital literacy and the four sub-dimensions of academic literacy. All correlation coefficients were greater than 0.5 and less than 0.8, with a significance level of $P < 0.01$, indicating that digital literacy is significantly correlated with all four sub-dimensions of academic literacy. Specifically, digital literacy exhibited the strongest correlation with the academic competence sub-dimension, and the weakest correlation with academic awareness. Consequently, digital literacy exerts the greatest influence on academic competence and the weakest influence on academic awareness. The specific results are shown in Table 15.

Table 15: Correlation Analysis between Digital Literacy and Academic Literacy's Sub-Dimensions

Variable Pairs	Correlation Coefficient: r	Significance Probability: p
Digital Literacy – Academic Awareness	0.519	0.000
Digital literacy – Academic Knowledge	0.644	0.000
Digital literacy – Academic Competence	0.723	0.000
Digital Literacy – Academic Ethics	0.575	0.000

The correlation coefficients between social network and four sub-dimensions of academic literacy were all around 0.5, indicating a moderate correlation. This suggests that the extent to which social network influences four sub-dimensions of academic literacy does not vary significantly. Among these, the correlation coefficient between social network and academic competence was slightly higher, at 0.571, whereas the correlation coefficient between social network and academic awareness was slightly lower, at 0.493. The specific results are shown in Table 16.

Table 16: Correlation Analysis between Social Network and Academic Literacy's Sub-Dimensions

Variable Pairs	Correlation Coefficient: r	Significance Probability: p
Social Network – Academic Awareness	0.493	0.000
Social Network – Academic Knowledge	0.500	0.000
Social Network – Academic Competence	0.571	0.000
Social Network – Academic Ethics	0.497	0.000

Effects of Digital Literacy and Social Network Sub-Dimensions on Academic Literacy

In this study, a total of eight dimensions—comprising the sub-dimensions of both digital literacy and social network—were used as independent variables, with academic literacy as the dependent variable. A stepwise regression analysis was conducted to explore the impact of each sub-dimension on academic literacy, and the resulting regression model is presented in Table 17.

Table 17: Regression Analysis Model

Model	R^2	Adjusted R^2	Standard Error of Estimate
1	0.470	0.468	0.425
2	0.558	0.554	0.389
3	0.609	0.603	0.367
4	0.615	0.609	0.364

Based on the values of adjusted R^2, it can be seen that Model 4 is of the highest quality, which incorporated four sub-dimensions (information data literacy, digital content creation, network centrality and network connection strength). The four dimensions—communication and collaboration, problem solving, network heterogeneity and network dynamism did not enter the model, indicating that their influence on academic literacy is not significant.

The adjusted R^2 value for Model 4 is 0.609, which means that these four variables account for 60.9% of the variation in academic literacy. Through the F test of model 4, it is found that the model passes the F test, and the p value is less than 0.05, indicating that at least one of the four variables will have a significant impact on academic literacy. The unstandardized coefficient values for information data literacy, digital content creation, network centrality, and network connection strength were 0.384, 0.232, 0.191 and 0.082 respectively. Their Sig values were all less than 0.05. Therefore, these four dimensions exert a significant positive influence on academic literacy. The multicollinearity test of Model 4 shows that the VIF values are less than 5, indicating that there is no serious collinearity problem. In addition, the DW value is 2.005, which is near the value 2, indicating that the model does not have autocorrelation. Consequently, the conclusions drawn from Model 4 are accurate and reliable. Specific data including the coefficients of the independent variables are shown in Table 18.

Table 18: Results of Model 4 Analysis (Dependent Variable: Academic Literacy)

Regression Model Summary							
R^2	**Adjusted R^2**		**F**	**Significance of F**	**DW**		
0.615	0.609		91.637	0.000	2.005		
-		Unstandardized coefficient	Standard error	Standardized coefficient	t	Sig.	VIF
Independent Variable	Information Data Literacy	0.384	0.054	0.379	7.065	0.000	1.714
	Digital Content Creation	0.232	0.045	0.283	5.208	0.000	1.756
	Network Centrality	0.191	0.046	0.215	4.171	0.000	1.581
	Network Connectivity	0.082	0.041	0.102	2.024	0.044	1.525
Constant	-	0.262	0.166	-	1.575	0.117	-

The Underlying Relationships Among Academic Literacy, Digital Literacy, and Social Network

Having sufficiently demonstrated that the various dimensions of academic literacy are directly influenced by digital literacy and social network, this study further explored the potential underlying relationships or mediating effects between these two independent variables.

The Confirmatory Factor Analysis of Internal Logic

To further explore the interrelationships among the variables, this study employed structural equation modeling (SEM) via AMOS to model the proposed theoretical framework. The resulting model exhibited key fit indices of RMSEA = 0.071 (< 0.08), NFI = 0.931 (> 0.9), and CFI = 0.962 (> 0.9), indicating a good model fit. The adjusted structural equation model is shown in Figure 4.

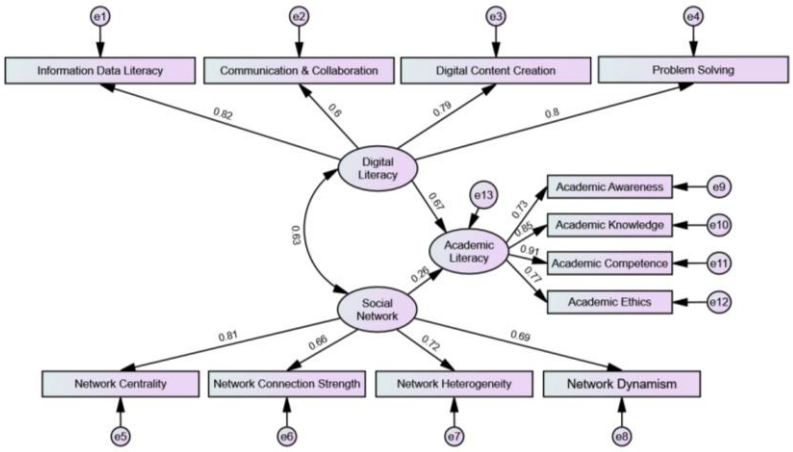

Figure 4: Structural Equation Model of Undergraduates' Academic Literacy

As shown in Figure 4, the path coefficient of digital literacy on academic literacy is 0.67, while that of social network is 0.26. This indicates that digital literacy exerts a greater influence on academic literacy than social network does, yielding a larger effect size. Of the four dimensions of academic literacy, academic competence exhibits the highest path coefficient (0.91) with academic literacy, demonstrating that it serves as the most representative indicator of undergraduates' academic literacy. Furthermore, the bidirectional path coefficient between digital literacy and social networks is 0.63 ($p < 0.01$), indicating a significant and strong positive correlation between the two variables.

Testing the Mediating Effects of Digital Literacy and Social Network

In order to further elucidate the underlying mechanisms linking digital literacy and social network, and verify the influence path of the two on academic literacy, this study tested the mediating effects of the two pathways: "digital literacy → social network → academic literacy" and "social network → digital literacy → academic literacy".

Digital Literacy → Social Network → Academic Literacy:

To conduct the analysis, the SPSS PROCESS macro was employed. A 95% confidence interval was set, and 5000 resamples were drawn using the bias-corrected non-parametric percentile bootstrapping approach. The final analytical results are detailed in Table 19. The data confirm that social network exerts a partial mediating effect between digital literacy and academic literacy, with a mediation effect of 20.72%. The direct effect of digital literacy on academic literacy is 79.26%.

Table 19: Analysis of The Mediating Effect of Social Network

	Effect Size	Boot SE	Boot LLCI	Boot ULCI	Relative Effect Size
Total Effect	0.835	0.050	0.736	0.935	
Direct Effect	0.662	0.056	0.552	0.772	79.26%
Mediating Effect	0.173	0.043	0.095	0.262	20.72%

Social Network → Digital Literacy → Academic Literacy:

Similarly, the SPSS PROCESS macro was employed to examine the mediating role of digital literacy between social network and academic literacy. The analysis was conducted using a 95% confidence interval and 5000 resamples based on the bias-corrected non-parametric percentile bootstrapping approach. The results are detailed in Table 20.

Table 20: Analysis of The Mediating Effect of Digital Literacy

	Effect Size	Boot SE	Boot LLCI	Boot ULCI	Relative Effect Size
Total Effect	0.591	0.052	0.488	0.694	
Direct Effect	0.283	0.049	0.187	0.379	47.93%
Mediating Effect	0.308	0.046	0.225	0.404	52.07%

The results confirm that digital literacy exerts a partial mediating effect between social network and academic literacy, with a mediating effect of 52.07%, and the direct effect of social network on academic literacy is 47.93%. Synthesizing the test results of the two mediation paths mentioned above, it is evident that digital literacy can indirectly affect academic literacy through social network, and conversely, social network can also exert an indirect effect through the mediating role of digital literacy. This demonstrates a significant positive reciprocal relationship between digital literacy and social network, thus supporting hypothesis H3.

CONCLUSIONS AND SUGGESTIONS

Research Conclusions

Through the analysis of the data collected via the questionnaire survey, the study has explored the development of academic literacy among undergraduates and the influence of relevant factors on academic literacy. Based on the above data analysis, this section presents conclusions regarding the development of academic literacy among undergraduates and its influencing factors.

Significant Differences in Academic Literacy Development Across Different Undergraduate Groups

There are differences in undergraduates' self-assessed scores across the dimensions of academic literacy. Overall, the better students' objective academic performance, the higher their self-assessed academic literacy score. In terms of objective academic performance, academic ranking, number of publications, frequency of participation in academic activities, and publication in core journals all have a positive impact on students' self-assessed academic literacy scores.

Specifically, students ranked in the top 20% academically score significantly higher in their self-assessments across all dimensions of academic literacy compared to those in other ranking groups. Conversely, students in the bottom 50% report the lowest self-assessment scores. This indicates a close relationship between academic performance and self-evaluated academic literacy. Regarding publication experience, students with publication experience score significantly higher in their self-assessments for overall academic literacy and its sub-dimensions compared to those without such experience. In particular, students with core journal publications score much higher than those without, demonstrating that high-quality academic publishing experiences significantly foster a positive perception of one's own academic literacy.

Furthermore, the frequency of participation in academic activities also influences self-assessment scores. Students with six or more instances of participation in academic activities report the highest self-assessment scores, whereas those with no such experience score the lowest. This reflects the relationship between the frequency of academic practice experience and self-assessed academic literacy. These findings suggest that undergraduates' self-assessment of academic competence is largely driven by their objective academic performance. Students tend to construct their self-perception and evaluation of their own academic literacy based on their grades, research output and academic engagement. To a certain extent, this explains the practical rationale behind why many universities currently adopt objective academic performance as the core indicator for evaluating undergraduates' academic literacy.

Academic Competence as the Core Factor of Academic Literacy, with Research Process Design Ability Having the Greatest Impact

Mastery of research design standards and the ability to design research processes are the core factors playing a decisive role in undergraduates' academic literacy. Based on the results of paired sample t-tests between academic literacy and its sub-dimensions, the academic competence sub-dimension is most closely associated with overall academic literacy ($r = 0.968$), and the difference in their mean values is not statistically significant ($t = -1.946$, $p = 0.053 > 0.05$). Furthermore, in the structural equation model constructed, the path coefficient for the effect of academic competence on academic literacy is the highest. This further demonstrates the central role of academic competence within the structure of academic literacy from the perspective of model validation. Among the three sub-dimensions of academic competence, research process design ability exhibits the highest correlation coefficient with overall academic competence ($r = 0.884$), and the difference in mean values is significant ($t = -4.770$, $p < 0.001$). This indicates that research process design

ability is most closely associated with academic competence, serving as the most critical sub-dimension driving its development.

Research process design ability can be understood as the ability to scientifically design and propose solutions. Previous studies have shown that this ability is a key pillar of academic competence [40], which is further corroborated by the findings of this study. Taken together, research process design ability is the core factor driving the development of academic competence, whilst academic competence, as a sub-dimension of academic literacy, is most closely associated with academic literacy. Therefore, it is reasonable to infer a hierarchical progressive influence mechanism from research process design ability to academic competence and then to academic literacy. Elucidating this influence mechanism not only helps to clarify the hierarchical relationships among the internal dimensions of undergraduate academic literacy, but also provides empirical basis for future research on development mechanisms of undergraduates' academic literacy.

Significant Influence of Digital Literacy on Academic Literacy and Its Association with Social Network

The positive influence of digital literacy and social network on undergraduates' academic literacy exhibits a relatively significant overall effect. Based on the correlation coefficients between digital literacy, social network, and their respective sub-dimensions with academic literacy, it can be observed that the influence of overall digital literacy ($R^2 = 0.662$, $p < 0.05$) and overall social network ($R^2 = 0.283$, $p < 0.05$) have a greater impact on academic literacy than their individual sub-dimensions. In other words, it is the combined effect of the sub-dimensions of digital literacy and social networks that generates their strong impact on academic literacy. These sub-dimensions cannot produce the same effect when acting independently. Specifically, four sub-dimensions—information data literacy, digital content creation, network centrality, and network connection strength—have a particularly strong influence on undergraduates' academic literacy. Information literacy is one of the most representative digital literacy skills in academic contexts [41], and the centrality and strength of social network constitute important perspectives in the study of dynamic social network [42]. This further demonstrates that within the dynamic process of academic literacy development, the prominent influence of these four sub-dimensions identified in this study is of significant research value.

Digital literacy and social network exert a significant positive influence on each other, acting as mutual mediators influencing the development of undergraduates' academic literacy. Specifically, in the path from social network to academic literacy, the indirect effect via digital literacy accounts for 52.07% of the total effect, exceeding the direct effect (47.93%). Meanwhile, social network mediates 20.72% of the overall effect in the path from digital literacy to academic literacy. Existing research has found that digital literacy is a key factor for college students to effectively adapt to the digital academic environment, and the practice network formed in this comprehensive environment can further provide academic support for students [43]. Given that their independent value in cultivating students' academic literacy has been widely recognized, it is now more important to consider how to leverage the synergistic role of digital literacy and social network, thereby further promoting undergraduates' academic literacy.

Countermeasures and Suggestions

Prioritizing Research Process Design in the Development of Academic Competence

Self-efficacy refers to an individual's internal conviction regarding their ability to successfully accomplish a given task [44]. Undergraduates' self-evaluation of academic literacy is essentially an explicit representation of their academic self-efficacy. Consequently, the influence that research process design ability exerts on student' self-assessed academic literacy inherently translates into an impact on their academic self-efficacy. Studies have confirmed the influence of academic self-efficacy on students' research training and scholarly identity [45]. Therefore, the cultivation of academic competence among undergraduates should shift away from the current overemphasis on theoretical knowledge and final outcomes, advancing the core focus of academic training to the "design" phase. Emphasis should be placed on "integrating research into teaching" and "transforming teaching into research" [46]. Universities should increase problem-oriented research methodology courses to train undergraduates' full-cycle research design capabilities, ranging from identifying research directions to planning research procedures. Faculty guidance should focus on facilitating students' substantive engagement in the early-stage framework development and feasibility analysis of research projects. The gap between theory and research practice should be bridged through multiple rounds of trial and error.

Promoting the Deep Integration of Digital Literacy and Academic Literacy

With the digital transformation of higher education, the academic ecosystem is also facing changes in research output and community engagement [47]. In this context, some researchers have extended the concept of "digital scholarship", arguing that it encompasses a dual-layered connotation: digital technologies and novel modes of scholarly communication [43]. The empirical analysis in this study indicates that digital literacy and social network play a mutually reinforcing role in the development of undergraduates' academic literacy. This not only transcends the isolated impact of the two factors acting as standalone elements in shaping undergraduates' academic literacy, but also demonstrates the feasibility and necessity of building a digital scholarship ecosystem. The cultivation of academic literacy should transcend the limitations of traditional physical academic spaces to create integrated online and offline digital collaborative academic environments, such as online data analysis laboratories and scholarly exchange communities. Higher education institutions should guide students to proactively acquire and process data within digital environments, transforming it into visualized outcomes. Meanwhile, by leveraging the interactive features of digital platforms, institutions should promote the construction of a multidisciplinary, multi-peer, and multi-mentor academic training system. This will ultimately achieve the deep integration of digital literacy and social network within academic practice processes.

Optimizing a Diverse and Dynamic Academic Evaluation System

Academic evaluation plays a central guiding role in academic development, and the establishment of a scientific and authoritative evaluation system is the prerequisite for fostering a high-quality academic ecosystem [48]. Therefore, cultivating academic literacy

among undergraduates must begin with the refinement of the existing undergraduate academic evaluation system. Firstly, it is essential to promote the diversification of academic evaluation in terms of both dimensions and evaluators. Research has shown that scholars from different disciplines follow distinct academic trajectories in their professional development [49]. For undergraduates, varying disciplinary backgrounds similarly result in diverse academic ecosystems. Consequently, differentiated evaluation criteria should be formulated based on the specific research paradigms and disciplinary principles [50]. Meanwhile, the scope of academic evaluators should move beyond the limitation of a single supervisor's assessment. Relevant academic network participants centered on the individual student, such as peer review and cross-disciplinary expert evaluation, should be included instead. Furthermore, the dynamic nature of academic evaluation should be emphasized. As the development of academic literacy is a long-term process, the evaluation system should overcome the outcome-oriented paradigm that relies on absolute criteria such as competition awards and the number of publications. Universities can utilize digital academic network platforms to establish undergraduate academic e-portfolios, which record and quantify their participation in academic activities such as literature review and academic seminars. It can contribute to facilitating the formative assessment of undergraduates' academic literacy development process.

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