

**Predicting Digital Literacy in Higher Education: The Role of Personal Factors**Yanhuan Li¹, Nurwina Akmal Binti Anuar^{2*}, Ahmad Zamri Bin Mansor³, Jianliang Xing⁴**ARTICLE INFO****ABSTRACT****Article History:**Received: 01 September 2024
Received in revised form: 20 December 2024
Accepted: 30 December 2024
DOI: 10.14689/ejer.2024.114.10**Keywords**

Digital Literacy, Personal Factors, Higher Education, Role of Personal Factor, Education

Background: Digital literacy has emerged as an essential competency enabling students to engage effectively within academic and professional contexts. With the growing integration of digital technologies in higher education, a comprehensive understanding of students' digital capabilities is vital for the development of informed curricula and appropriate support strategies. **Objectives:** This study seeks to evaluate the digital literacy levels of higher education students in Shandong Province, China, and to examine the personal and contextual factors that impact the development of these competencies. **Methods:** A

quantitative research approach was adopted, utilising the Digital Literacy Questionnaire. The survey was distributed to a sample of 400 higher education students. Descriptive statistical analysis was performed using SPSS software to assess proficiency levels across various dimensions of digital literacy. **Results:** The findings reveal that students in Shandong Province possess an average level of proficiency in Computer and ICT skills, while exhibiting a high degree of competence in fundamental Internet skills. Their ability to search for and retrieve information was assessed as moderate, although they employ a variety of channels to access informational resources. Students demonstrated considerable effectiveness in utilising information, particularly in the critical evaluation of content. Nevertheless, they encounter difficulties related to information authority, access efficiency, and the limited availability of trustworthy information sources. Moreover, the results highlight significant disparities in digital literacy between students from rural and urban settings. Personal variables, including academic performance, educational background, and family circumstances, were also identified as influential factors affecting specific aspects of digital literacy. **Conclusion:** The study underscores the necessity for specialised digital literacy training within higher education, which should be customised to accommodate individual learning preferences, levels of motivation, and prior knowledge. Furthermore, offering support and professional development opportunities for academic staff can enhance their involvement and play a pivotal role in advancing students' digital literacy.

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Introduction

With the rapid advancement and widespread adoption of information technology, the digital society has become an increasingly integral aspect of both personal and professional life. Within this context, digital literacy—defined as an individual's capacity to comprehend, apply, and disseminate digital information—has gained recognition as a core competency of the 21st century (European Parliament and the Council, 2006). Its importance has grown substantially, particularly within the educational sector. Digital literacy not only contributes to academic achievement but also directly influences individuals' competitiveness and adaptability in an increasingly digitalised society. Higher education institutions play a pivotal role in cultivating students' digital skills to enhance their employability (Arsenis et al., 2021). Enhancing students' digital literacy is therefore essential to align their competencies with the evolving demands of the labour market (Bousrih et al., 2022). Assessing students' digital literacy levels is a critical step in shaping effective educational interventions. It is also necessary to define clearly the specific digital literacy competencies that university students are expected to acquire.

China, with one of the largest Internet user populations globally, continues to expand its influence in the digital technology sphere. Despite rapid technological progress, a widening gap in digital competence remains evident, reflecting disparities in access and ability. Enhancing the digital literacy of university students is particularly vital, as they represent the future drivers of national development. Accordingly, examining the digital literacy levels of Chinese higher education students and the factors shaping these competencies not only facilitates evaluation of current educational policy effectiveness but also contributes to the broader improvement of student quality and educational standards.

This study aims to critically analyse the current state and challenges of digital literacy among Chinese university students. Through empirical investigation, it explores developmental trends and the variables influencing digital competencies. By comparing students from diverse academic and socio-economic backgrounds, the research provides both theoretical insights and practical recommendations to elevate digital literacy levels. The intention is to offer a comprehensive understanding of the digital literacy landscape among Chinese higher education students, highlight prevailing issues and their implications, and deliver valuable guidance to educators, administrators, and policymakers in supporting the digital transformation of higher education and enhancing students' overall academic and professional experiences. The concept of digital literacy was introduced by Gilster in 1997, referring to the ability to access, comprehend, and integrate digital information, and to use Information Society Technology (IST) confidently and critically for communication, work, and daily life (Gilster, 1997). Since then, the concept has evolved, with scholars expanding its definition in response to the emergence of the digital economy and the increasing integration of digital tools into everyday activities. In this context, "students' digital literacy" has been conceptualised as:

It is primarily comprised of three elements: the first is "universal literacy," which refers to the use of digital platforms and tools, as well as the acquisition, assessment, sharing, and communication of digital resources; the second is "interdisciplinary literacy," which denotes the integration of courses in various academic fields and contexts. Third, keeping understanding of legal and ethical principles as well as maintaining digital security on the Internet is referred to as digital ethical literacy (Murphy, 2023).

Research into students' digital literacy in China has emerged as a significant topic over the past decade. As noted by [Huang et al. \(2021\)](#), prior to 2018, only 66 studies had been conducted on the subject of "college students' Internet literacy" in China, with the majority focusing on conceptual and definitional analysis. Three principal approaches have commonly been employed to describe "college students' Internet literacy": competency-based descriptions, dimension-based frameworks, and philosophical or vision-oriented interpretations. In recent years, however, there has been a notable increase in empirical investigations into students' digital literacy. Although most students in higher education demonstrate a basic capacity for information retrieval—particularly through platforms such as Baidu and similar search engines—numerous studies continue to highlight deficiencies in their digital competencies.

[Gumede \(2021\)](#) reported that 74.9% of students were unaware of their university library's specialised digital resources and lacked the ability to utilise authoritative academic databases, thereby indicating a significant gap in digital literacy. Similarly, [Rafi et al. \(2019\)](#) found that 35.2% of college students exhibited either average or poor skills in information integration. [Al-Rasheed and Berri \(2016\)](#) noted that only 12% of students were proficient in repurposing digital content and selecting suitable media for effective knowledge expression. Moreover, findings from [Tazi et al. \(2023\)](#) jointly revealed that 65.8% of students were not adequately capable of safeguarding their online privacy. [Zhengqiang \(2020\)](#) further argued that students in higher education often lack critical thinking and problem-solving abilities within the digital sphere.

Digital literacy encompasses a wide range of competencies and skills that enable individuals to navigate and utilise digital environments effectively. It extends beyond mere computer literacy to include the ability to gather information, critically evaluate digital content, and demonstrate ethical practices when engaging with online resources ([Fiannaca, 2024](#)). Success in higher education increasingly depends on students' digital literacy, as it facilitates their interaction with learning management systems, efficient access to digital databases, and meaningful participation in virtual learning spaces. Academic achievement thus requires an understanding of the distinctions between credible and non-credible online sources, the maintenance of digital security, and the ability to manage evolving digital technologies. As [Hristovska \(2023\)](#) asserts, technical proficiency represents only one component of digital literacy, which also involves cognitive knowledge, responsible digital citizenship, and the capacity to resolve problems and adapt to technological change.

Students' digital literacy is largely shaped by personal attributes. High academic performers tend to show advanced digital competencies, especially in research, collaboration, and information management tasks ([Ibrahim & Aldawsari, 2023](#)). These students actively engage with digital learning platforms, seeking resources to support academic growth, while lower-performing peers often lack motivation and confidence, limiting their use of digital tools. Educational background also affects digital literacy development ([Julian Fraillon, 2025](#)). Students exposed to technology early are more digitally proficient, whereas those without such exposure require additional support. Digital preparedness for higher education stems from the quality of digital instruction in earlier schooling. Institutions with early tech integration produce students with stronger digital skills, while traditional methods leave others underprepared.

Family background is another key factor. Parental education and household income influence digital competence (Adigwe et al., 2024). Educated parents often provide guidance in digital navigation, while wealthier families afford better access to devices and stable internet, unlike low-income households, which face barriers to digital skill development. Universities also play a critical role by embedding technology into curricula and offering digital resources (Odoh & Nwokwu, 2024). With the rise of blended and online learning, digital proficiency is essential. Students' skills vary based on prior exposure, institutional support, and personal attitudes towards technology (Alenezi et al., 2023). While social media use is widespread, students often struggle when academic tasks require advanced research or critical thinking. Successful digital literacy education depends on accessible resources and institutional commitment. Some universities implement structured programmes, while others rely on informal learning. Comprehensive strategies help students address challenges in information retrieval, cybersecurity, and online ethics. As digital environments evolve, students must develop adaptive skills to thrive in a dynamic digital society (Istrate & Velea, 2024).

Academic and professional success depends on digital literacy, which students recognise; however, their commitment to developing these skills varies (Wang & Si, 2024). Students often express interest in acquiring digital competencies, particularly for information retrieval, data protection, and content management. Nonetheless, participation in formal digital literacy training remains inconsistent. Many avoid structured courses, assuming that digital skills are naturally acquired through regular technology use (Aldhaen, 2023). Therefore, digital literacy initiatives should emphasise how these skills contribute directly to academic achievement and career advancement. Since digital competence is vital across sectors – business, healthcare, engineering, and the humanities – universities can enhance engagement by contextualising digital literacy within academic disciplines (Falloon, 2020). Mandating digital literacy training within the curriculum, rather than offering it as an optional component, could significantly improve student participation and outcomes.

While most students show proficiency in digital tools, they often struggle to access reliable information from credible sources (López-Meri et al., 2024). Barriers include limited access to academic databases, the overwhelming volume of online content, and difficulty distinguishing reliable sources from misinformation. Inefficient search strategies further hinder information retrieval (Shah & Bender, 2024). These issues highlight the need to teach source credibility analysis and enhance research training. Institutions can support students by offering digital library services, academic search tools, and targeted training sessions (Rafiq, 2024), ultimately improving content evaluation, reducing misinformation exposure, and enhancing research quality.

Despite being considered a digitally native generation, many students still show weak information literacy (Youqun, 2020). Zhao et al. (2022) found a digital gap among Chinese university students, with urban students in Hubei Province showing higher digital literacy than their rural peers. However, limited research exists on the digital literacy of students in Shandong Province, especially regarding rural disparities. This study aims to investigate whether digital poverty exists among rural students and whether regional variation in digital literacy is present in Shandong. Although rural digital infrastructure in China has improved significantly, access disparities between rural and urban students remain (Luo

et al., 2022). Variations are also evident in how students utilise digital technologies. Guo (2021) identified personal characteristics—grades, degree type, and academic performance—as key influences on digital literacy. This study will also consider variables such as age, gender, academic discipline, number of apps used, and family background to determine their impact on students' digital literacy (Sun et al., 2022).

Hypotheses

H1: Students from urban areas have higher digital literacy levels than students from rural areas in Shandong Province.

H0: There is no significant difference in digital literacy levels between students from urban and rural areas in Shandong Province.

H2: Personal factors such as academic performance, educational background, and family background significantly influence students' digital literacy.

H0: Personal factors such as academic performance, educational background, and family background do not significantly influence students' digital literacy.

H3: Students with higher academic performance exhibit higher digital literacy levels compared to those with lower academic performance.

H0: There is no significant difference in digital literacy levels between students with higher and lower academic performance.

Method

Samples

Higher education students in Shandong Province form the survey population. In mathematical statistics, a population refers to the entire group under investigation. According to the Shandong Provincial Educational Development Statistical Bulletin 2022, there were 2,429,900 regular higher education students in the province (Wang et al., 2022). The list of institutions was sourced from the official website of China's Ministry of Education. As of September 2023, Shandong had 156 higher education institutions: 3 directly under the Ministry of Education, 44 private universities, and 109 public universities. Public institutions were further categorised into 42 undergraduate colleges and 67 junior colleges. Due to variations in government investment and educational quality, this study focused exclusively on the 42 public undergraduate colleges and universities. Other types of institutions were excluded. A simple random sampling method was applied, and following Krejcie and Morgan (1970) sampling table, a final sample of 400 higher education students in Shandong Province was selected.

Instruments

Questionnaire surveys are commonly used to gather data due to their efficiency in collecting a large number of samples quickly and at a low cost. This study employed a questionnaire survey to assess the digital literacy levels of higher education students. The questionnaire consisted of three parts. The first part included an explanation of the survey's purpose, which was to collect data on university students' digital literacy for academic research. Respondents were encouraged to answer honestly, with the assurance that their

responses were anonymous and their personal information confidential. The second part of the questionnaire gathered basic demographic information, such as gender, age, the number of apps used, and family factors. The third part focused on assessing the digital literacy and abilities of Chinese college students.

The instrument used was the Digital Literacy of Students Questionnaire, based on Shopova (2014) version, which was translated into Chinese. The questionnaire included six sections, which addressed: (1) students' computer literacy; (2) access to and basic skills for using the Internet; (3) information retrieval and access capabilities; (4) the frequency of using various information resources; (5) the effective use of information and critical thinking skills; and (6) students' attitudes and motivations to participate in ICT training and other activities aimed at improving their digital technologies.

Procedure of Data Collection and Analysis

Since the scale was directly translated from Shopova (2014), cultural differences were inevitable. To ensure better adaptation to the language preferences of Chinese college students, three paper versions of the questionnaire (comprising 35 items across five constructs; see Table 1) were distributed starting November 8, 2023. Students were asked to provide feedback on the translated items, and any items whose semantic meaning was unclear were modified based on their suggestions. After incorporating the feedback from the three subjects, five Chinese questions were slightly adjusted in terms of expression. Due to the distribution across different cities in Shandong Province and considerations of time and cost, an online questionnaire was used for broader distribution. The widely used platform, Questionnaire Star, was employed to ensure applicability, with a setting to allow each device or IP address to submit only one response. By November 28, 2023, a total of 399 online questionnaires were collected, out of which 350 were valid. The invalid responses were filtered out: two questionnaires were from institutions outside public universities in Shandong Province, one questionnaire had incorrect educational level data, 16 responses were completed in less than 120 seconds, and 24 questionnaires in the second part of the digital literacy scale where all answers were scored as 1 were excluded. Additionally, six questionnaires with identical years of computer usage and age were discarded. To further enhance the quality of the responses, 54 paper versions of the questionnaire were distributed, with 50 valid responses returned. In total, 400 valid questionnaires (both paper and online) were collected, covering all constructs listed in Table 1, yielding a recovery rate of 88.3%.

Table 1

Constructs of Students' Digital Literacy Questionnaire Shopova (2014).

Constructs	Remark Column	Items
Ability of students to work with computer / ICT	SDL1	6
Internet access	SDL2	7
Ability to retrieve and access information	SDL3	7
Use of information resources	SDL4	7
Skills for effective use of information	SDL5	8
Total	/	35

Results And Discussion

Demographic

SPSS 27.0 was used to analyse the collected data from 400 college students across 18 universities. The sample was composed of 44.8% male and 55.3% female participants, showing a slight gender disparity with more females than males. The average age of participants was 20.55 years. Regarding education level, 76% were undergraduates and 24% were postgraduates. The average computer usage among students was 6 years, with 74.1% using computers for 1-12 years. A majority of students (95%) reported using screens between 2 and 14 hours per day, and most students (91.5%) used the Internet daily. In terms of mobile phone apps, 5.5% used fewer than 10 apps, while the majority used between 11-40 apps, with 15.5% using more than 50 apps. Regarding the impact of teachers' digital abilities on students' digital literacy, 377 valid responses were collected. The average rating was 7.18 (on a scale of 0-10, with 0 being "Unaffected" and 10 being "Great Influence"), indicating that academics generally believe teachers' digital abilities have a significant impact on students' digital literacy (see Table 2).

Table 2

Demographic Characteristics of Higher Education Students

	Frequency	Percent (%)	Mean
Gender			
Male	179	44.75	
Female	221	55.25	
Total	400	100.00	
Age			
<18	2	0.5	
18-22	311	77.9	
23-26	82	20.6	
>27	4	1.0	
Total	399	100.0	20.55
Degree			
Undergraduate	304	76	
Postgraduate	96	24	
Total	400	100.00	
Grade			
Freshman	96	24.0	
Sophomore	182	45.5	
Year 3	96	24.0	
Year 4	26	6.5	
Academic Performance			
≥90 scores	54	13.5	
80-89 scores	181	45.3	
70-79 scores	86	21.5	
60-69 scores	37	9.3	
Others	42	10.5	
Total	400	100.0	2.35

	Frequency	Percent (%)	Mean
How long have you been using a computer? ___ (years)			6.081
Number of apps used on mobile phones			
Less than 10	22	5.5	
11-20	99	24.8	
21-30	106	26.5	
31-40	87	21.8	
41-50	24	6.0	
More than 50	62	15.5	
Total	400	100.0	3.45
Daily Screen Time			
Less than 2 hours	9	2.3	
2-6 hours	151	37.8	
6-10 hours	188	47.0	
10-14 hours	41	10.3	
More than 14 hours	11	2.8	
Total	400	100.0	2.74
Teachers' digital competencies affect students' digital literacy? ((Unaffected)0-10(Great Influence))			7.18
Use the Internet			
Everyday	366	91.5	
Several Days	34	8.5	
Total	400	100.0	

Descriptive Analysis

Computer /ICT Skills of Students

This descriptive analysis presents the mean scores for each task, using a scale from 1 to 3, across varying proficiency levels (Excellent, Very Good, Good). It offers an overview of how respondents perceive their proficiency in each task. The results indicate that the majority of respondents consider their ICT skills to be very good. Although this finding cannot be directly compared with the results of Shopova (2014), given the passage of 10 years and the differing national contexts, the overall improvement in digital skills is significant. However, the skill level for using the operating system to access information remains lower than Shopova (2014)'s findings, where 96% of participants rated their proficiency as excellent (see Table 3).

Table 3

Computer /ICT Skills of Students

Computer /ICT Skills of Students	Excellent	Very Good	Good	Mean
Using the operating system to access the information	25.0	54.8	20.3	1.95
Working with computers to access the information	32.0	52.5	15.5	1.84
Word processing	27.3	56.8	16.0	1.89
Using the Microsoft Excel, databases, etc.	23.0	54.8	22.3	1.99
Creating and formatting documents, tables, pictures, and images	28.0	54.5	17.5	1.90
Creating presentations and slideshow presentations	27.0	57.0	16.0	1.89

Internet Access and Basic Students' Internet Skills

This analysis offers an overview of the distribution of internet skills among students, highlighting areas of strength as well as areas that may require further improvement or support. A notable proportion of students, 21%, lack proficiency in using the World Wide Web (WWW). Additionally, 18.5% of students lack proficiency in creating their own web pages with text, images, and hyperlinks. Overall, the levels of internet access and basic internet skills are relatively high (see Table 4).

Table 4

Internet Access and Basic Students' Internet Skills

Internet Access and Basic Students' Internet Skills	Yes	Partly	No	Mean
Using the WWW	41.00	38.00	21.00	1.80
Using search tools to find and retrieve information	63.50	33.50	3.00	1.40
Identifying the search results	59.50	36.00	4.50	1.45
Using E-mail	58.75	37.75	3.50	1.45
Creating and sending emails, and working with attachments	60.50	35.00	4.50	1.44
Understanding the basic Internet concepts	53.75	42.75	3.50	1.50
Creating own web pages with text, images, and hyperlinks	43.75	37.75	18.5	1.75

Students Ability for Seeking and Retrieving Information

Most students demonstrate at least partial ability in seeking and retrieving information, with relatively high percentages in the "Yes" and "Partly" categories across all skills.

Table 5

Students' Ability for Seeking and Retrieving Information

Students' Ability for Seeking and Retrieving Information	Yes	Partly	No	Mean
Effective and efficient access to information	50.70	47.00	23.00	1.52
Satisfaction with information search	34.25	62.25	3.50	1.69
Identification of key concepts and terms that describe the information need	50.70	47.00	23.00	1.52
Determination of different types and formats of potential sources of information (eg, multimedia, databases, audio / video, book)	52.25	44.75	3.00	1.51
Construction of strategies for locating information	35.25	52.00	12.75	1.78
Differentiation of the major characteristics of separate library information resources on the web	33.00	56.75	10.25	1.77
Identifying types of resources in the catalogue of the electronic university library	23.75	60.75	15.50	1.92

Satisfaction with information search shows the highest percentage, 62.25%, in the "Partly" category, suggesting that while students are somewhat satisfied, there is still room for improvement. A notable discrepancy is observed in the ability to identify types of resources in the university library catalogue, where 60.75% of students fall into the "Partly" category, with only 23.75% in the "Yes" category, a lower percentage compared to other skills (see Table 5). The most commonly used search engines, ranked from highest to lowest, are Baidu Browser, Microsoft Edge, Quark Browser, QQ Browser, with Google

Browser being the least frequently used (see Table 6). Overall, while students exhibit some proficiency in seeking and retrieving information, there are areas where further improvement or support could be beneficial to enhance their skills.

Table 6

What Search Engine Do You Mainly Use?

		Google	Quark	Baidu	Microsoft Edge	QQ Browser	Others
Number of Cases	Valid	400	400	400	400	400	400
	Missing	0	0	0	0	0	0
	Frequency	179	228	328	235	188	15

Use of Information Resources by Students

The most frequently used resource among students is online video, with 59.25% of students reporting regular usage. This is followed by e-media and online photo galleries, each with 42% of students using them regularly. In terms of mean scores, online video (Mean = 1.47) is the most popular resource, while virtual museums (Mean = 2.63), digital libraries (Mean = 2.28), and print media (Mean = 2.24) are the least popular (see Table 7).

Table 7

Use of Information Resources by Students

Use of Information Resources by Students	Regularly	Sometimes	Rarely	Never	Mean
Print media - newspapers, magazines, books, encyclopaedias, etc	17.75	45.25	32.75	4.25	2.24
E-media - newspapers, magazines, books, encyclopaedias, etc.	42.00	43.75	11.50	2.75	1.75
Online video	59.25	35.00	5.00	0.75	1.47
Electronic audio records	34.75	42.75	19.75	2.75	1.91
Online photo galleries	42.00	39.50	14.75	3.75	1.80
Virtual museums	11.25	35.25	33.00	20.50	2.63
Digital libraries	22.80	39.25	25.25	17.25	2.28

A significant portion of students rarely uses print media (32.75%), with many reporting occasional or infrequent usage. Virtual museums and digital libraries are less frequently used, with 20.5% and 17.25% of students respectively reporting never using them. However, digital libraries are regularly or occasionally used by 62.5% of students, highlighting their importance in academic research. Virtual museums (11.25%), print media (17.75%), and digital libraries (22.80%) are used less frequently compared to other resources, with notable portions of students rarely or never using them.

Students' Skills for Effective Use of Information

In terms of proficiency, students demonstrate the highest ability in adhering to laws, regulations, and etiquette regarding information usage, with 52.75% reporting full proficiency in this area. However, critical evaluation of print and online sources, and the verification of data authenticity and reliability, show lower proficiency. Specifically, 9% of

students cannot perform this skill, and a higher percentage (60.50%) report partial proficiency (see Table 8).

Table 8

Use of Information Resources by Students

Students' Skills for Effective Use of Information	Yes	Partly	No	Mean
Analysing and synthesizing information	34.5	61.25	4.25	1.70
Comparing the information obtained from different sources	47.75	49.25	3.00	1.55
Interpretation and presentation of information	44.50	51.20	4.30	1.60
Critical evaluation of information and sources	39.25	56.00	4.75	1.66
Critical evaluation of print and online sources based on specific criteria	30.50	60.50	9.00	1.79
Verification of the authenticity and reliability of the data collected	33.00	60.50	6.5	1.74
Understanding of what the copyright is and its ethically use	42.80	50.2	7.00	1.64
Following laws, regulations, etiquette related to the access and use of the information resources	52.75	43.00	4.25	1.52

Summary

Overall, students exhibit varying levels of proficiency across different skills, with notable room for improvement, especially in critical evaluation and verification of information. The scale, which assigns scores from 1 to 4 based on digital literacy proficiency, indicates that lower scores correspond to higher proficiency levels (see Figure 1). The data reveals consistent distribution across different levels for most skills, except for SDL4, which pertains to the preferred information resources students use.

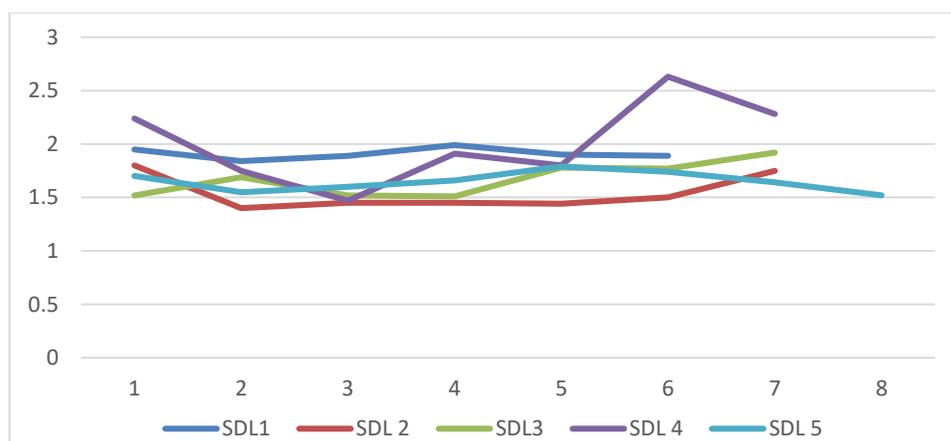


Figure 1: Means of Each Dimension of Digital Literacy

As indicated by the mean scores, SDL2 (Internet access and basic internet skills) had the highest proficiency level (Mean = 1.54), while SDL4 (Use of information resources) was the

least proficient skill, with a mean score of 2.01, demonstrating a significant gap within the group and poor stability in this area. Following this, SDL1 (Ability of students to work with computer/ICT) had a mean score of 1.91, suggesting that overall proficiency in this skill also requires improvement (see Table 9).

Table 9

The Mean Value of Each Dimension of Students' Digital Literacy

Mean Value	SDL 1	SDL 2	SDL 3	SDL 4	SDL 5
Item 1	1.95	1.8	1.52	2.24	1.7
Item 2	1.84	1.4	1.69	1.75	1.55
Item 3	1.89	1.45	1.52	1.47	1.6
Item 4	1.99	1.45	1.51	1.91	1.66
Item 5	1.9	1.44	1.78	1.8	1.79
Item 6	1.89	1.5	1.77	2.63	1.74
Item 7		1.75	1.92	2.28	1.64
Item 8					1.52
Average Mean	1.909	1.5414286	1.6728571	2.0114286	1.6488

Personal Factors

Residential Area

An independent sample T-test was conducted to compare the digital literacy levels of students based on their residential region. The results revealed statistically significant differences across all five dimensions of digital literacy, with a p-value (Sig. (2-tailed)) of less than 0.05, indicating significant disparities between urban and rural students (see Table 10). According to the mean analysis, students from urban areas demonstrated higher levels of digital literacy than their rural counterparts, as reflected by the lower mean scores, which signify greater proficiency in digital literacy. Figure 2 provides a visual representation of these regional differences in digital literacy.

Table 10

Independent Samples Test – Residential Area

	Residential Area	Number of Cases	Mean	SD	F	Sig. (2-Tailed)	t
SDL1	Rural	218	2.0008	.59729	.454	.001***	3.485
	Urban	182	1.7985	.56118			
SDL2	Rural	218	1.6114	.47131	4.391	.001***	3.471
	Urban	182	1.4545	.43198			
SDL3	Rural	218	1.7313	.44809	.657	.003**	2.969
	Urban	182	1.5981	.44593			
SDL4	Rural	218	2.0839	.54124	.014	.003**	3.022
	Urban	182	1.9223	.52507			
SDL5	Rural	218	1.74140	.460568	.360	.000***	4.604
	Urban	182	1.53777	.422966			

Note. SD = Standard Deviation; * p < 0.05 ** p < 0.01 *** p < 0.001.

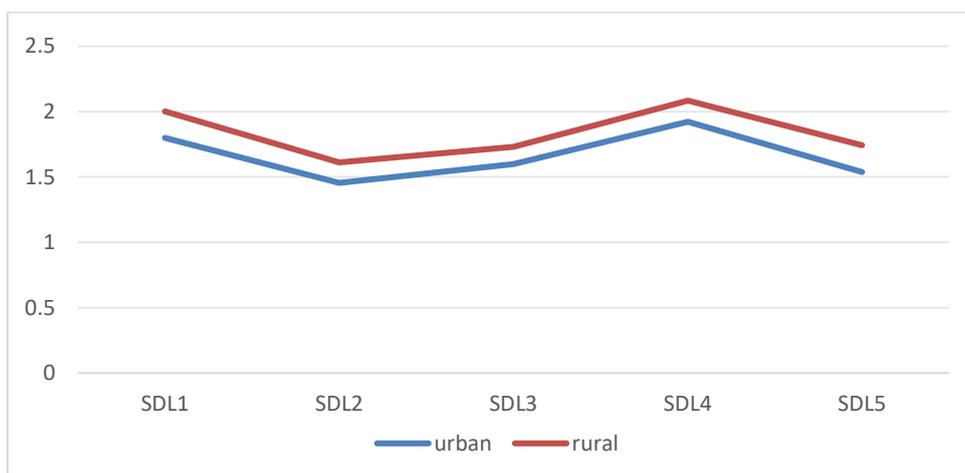


Figure 2: Residential Area Differential in 5 Dimensions of Digital Literacy

Gender

The Independent Samples Test was performed on the gender variable. Given that the significance value (Sig.) from the F-test (homogeneity of variance test) is less than 0.01, it is assumed that the variances between the two groups (male and female) are not equal. Therefore, attention is given to the Sig. (2-tailed) value, which is less than 0.05, indicating a significant difference between the two groups. If the Sig. value were greater than 0.05, the null hypothesis would be accepted, suggesting no significant difference between the groups. The results, as presented in Table 11, reveal significant differences between male and female students in the following areas: Ability to work with computers/ICT (SDL1), Ability to retrieve and access information (SDL3), and Skills for effective use of information (SDL5). In these three areas, male students demonstrated better performance compared to female students.

Table 11

Independent Samples Test - Gender

	Gender	Number of Cases	Mean	SD	F	Sig. (2-Tailed)	t
SDL1	Male	179	1.7803	.61616	14.698	.000***	3.948
	Female	221	2.0128	.54584			
SDL2	Male	179	1.5020	.46608	1.146	.137	-1.489
	Female	221	1.5708	.45370			
SDL3	Male	179	1.6057	.45939	3.687	.009**	-2.609
	Female	221	1.7233	.43896			
SDL4	Male	179	2.0160	.57700	3.133	.852	.187
	Female	221	2.0058	.50806			
SDL5	Male	179	1.59567	.452845	.257	.035*	-2.110
	Female	221	1.69174	.452816			

Note. SD = Standard Deviation; * p < 0.05 ** p < 0.01 *** p < 0.001.

Education Background

As the educational background data does not follow a normal distribution, the independent samples T-test was not applicable. Instead, a non-parametric Mann-Whitney U test was conducted. The results indicate that among the five dimensions of digital literacy, only SDL4 (Use of Information Resources) retains the null hypothesis, suggesting no significant difference. However, for the remaining dimensions (SDL1: Ability to work with computer/ICT, SDL2: Internet access and basic skills, SDL3: Ability to retrieve and access information, SDL5: Skills for effective use of information), the null hypothesis is rejected, indicating significant differences based on educational background. The comparison of mean values reveals that graduate students generally exhibit a higher level of digital literacy than undergraduate students. The lower the mean score, the higher the level of proficiency in digital literacy skills, suggesting that graduate students tend to have better digital competencies than their undergraduate counterparts (see Table 12).

Table 12

Mann-Whitney U Test with Regard to the Education Background Variable

Dimensions	U	Z	P	Decision	Education Background			
					Undergraduate		Postgraduate	
					Mean	SD	Mean	SD
SDL1	12179.00	-2.508	0.012	Reject the null hypothesis	1.9468	0.60723	1.7882	0.51212
SDL2	11204.00	-3.473	<0.001	Reject the null hypothesis	1.5907	0.47794	1.3795	0.3547
SDL3	12672.00	-1.982	0.048	Reject the null hypothesis	1.6866	0.46058	1.6205	0.41962
SDL4	13688.00	-0.923	0.356	Preserve the null hypothesis	2.0287	0.57253	1.9524	0.41439
SDL5	12286.00	-2.382	0.014	Reject the null hypothesis	1.67681	0.46092	1.5599	0.42495

Notes: a. The significance level was.050;

b. The progressive significance is shown

Academic Performance

Academic performance was divided into five groups, exhibiting a positive skewness distribution (see Figure 3). Among the 400 students, 54 scored above 90 points, 181 students (45.3%) scored between 80-89 points, 86 students scored between 70-79 points, 37 students scored between 60-69 points, and 42 students scored below 60 points, or were unable to provide a valid score for other reasons. The nonparametric Kruskal-Wallis test was employed as a differentiating variable to assess digital literacy across these academic performance groups. According to the SPSS analysis results, there were no statistically significant differences in the ability to access the internet (SDL2). However, significant differences were found in other aspects, including SDL1 (Ability to work with computer/ICT), SDL3 (Ability to retrieve and access information), SDL4 (Use of information resources), and SDL5 (Skills for effective use of information). Students with higher academic scores demonstrated better proficiency in all areas of digital literacy (see Table 13).

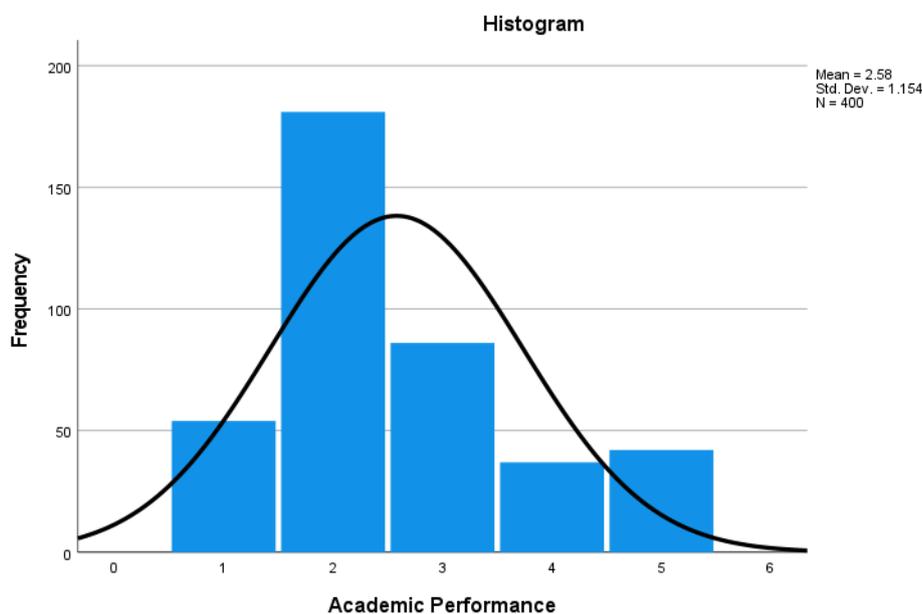


Figure 3: Histogram of Academic Performance

Table 13

Kruskal-Wallis Test Divided by Academic Performance

Dimensions	P	Decision	Academic Performance									
			≥90 Scores		80-89 Scores		70-79 Scores		60-69 Scores		Others	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
SDL1	0.002**	Reject the null hypothesis	1.7037	0.62417	1.8610	0.54419	2.0155	0.55756	1.9279	0.7228	2.1429	0.56976
SDL2	0.055	Preserve the null hypothesis	1.4550	0.436	1.4886	0.42779	1.6096	0.47730	1.61	0.588	1.6667	0.4264
SDL3	0.002**	Reject the null hypothesis	1.4921	0.4196	1.6361	0.4185	1.7525	0.46455	1.7452	0.53994	1.8163	0.442
SDL4	< 0.001***	Reject the null hypothesis	1.8095	0.484	1.95	0.488	2.063	0.592	2.1564	0.662	2.272	0.448
SDL5	0.01**	Reject the null hypothesis	1.49537	0.448	1.618	0.4124	1.6933	0.468	1.80743	0.52257	1.74702	0.49

Note. SD = Standard Deviation; * p < 0.05 ** p < 0.01 *** p < 0.001.

Father's Degree

The father's educational background data did not conform to a normal distribution, thus precluding the use of an independent samples t-test. Instead, a non-parametric Kruskal-Wallis test was applied. The results indicated statistically significant differences in the following areas of digital literacy: SDL1 (Ability to work with computer/ICT), SDL2 (Internet access), SDL3 (Ability to retrieve and access information), and SDL5 (Skills for effective use of information) based on the father's educational background. However, there were no significant differences in SDL4 (Use of information resources) across different father's educational levels (see Table 14).

Table 14

Kruskal-Wallis Test Divided by Father's Degree

Dimensions	P	Decision	Father's Degree							
			Junior High School and Below		Senior High School		Associated Degree		Bachelor's Degree and Above	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
SDL1	.000***	Reject the null hypothesis	2.0117	0.58742	1.8567	0.57687	1.8162	0.56298	1.6277	0.53974
SDL2	.003**	Reject the null hypothesis	1.6135	0.47050	1.4671	0.44153	1.4908	0.40512	1.4012	0.44347
SDL3	.003**	Reject the null hypothesis	1.7417	0.45483	1.6143	0.44648	1.6227	0.43785	1.5076	0.40385
SDL4	.268	Preserve the null hypothesis	2.0681	0.56936	1.9200	0.47416	1.9560	0.50151	1.9848	0.54213
SDL5	.008**	Reject the null hypothesis	1.7161	0.47226	1.5863	0.42850	1.6026	0.38246	1.5133	0.44174

Note. SD = Standard Deviation; * p < 0.05 ** p < 0.01 *** p < 0.001.

Mather's Degree

The mother's educational background data did not conform to a normal distribution, so an independent samples t-test could not be applied. Instead, a non-parametric Kruskal-Wallis test was used. The results revealed statistically significant differences in the following dimensions of digital literacy: SDL1 (Ability to work with computer/ICT), SDL2 (Internet access), SDL3 (Ability to retrieve and access information), and SDL5 (Skills for effective use of information), based on the mother's educational background. However, there were no significant differences in SDL4 (Use of information resources) across different levels of the mother's education. The influence of the father's and mother's educational backgrounds on students' digital literacy showed similar trends across the various dimensions (see Table 15).

Table 15

Kruskal-Wallis Test Divided by Mother's Degree

Dimensions	P	Decision	Mother's Degree							
			Junior High School and Below		Senior High School		Associated Degree		Bachelor's Degree and Above	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
SDL1	.004**	Reject the null hypothesis	1.9793	0.61433	1.8210	0.51759	1.8704	0.53876	1.6510	0.54766
SDL2	.011*	Reject the null hypothesis	1.6009	0.47902	1.4638	0.40376	1.4381	0.42792	1.4152	0.42836
SDL3	.002**	Reject the null hypothesis	1.7243	0.46540	1.5873	0.43213	1.6889	0.39157	1.4509	0.38591
SDL4	.317	Preserve the null hypothesis	2.0413	0.56335	1.9101	0.49200	2.0381	0.46531	1.9911	0.55618
SDL5	.002**	Reject the null hypothesis	1.70351	0.468436	1.58642	0.450972	1.65556	0.358694	1.38281	0.376927

Note: SD = Standard Deviation; * p < 0.05 ** p < 0.01 *** p < 0.001.

Number of Books in Home (Books)

The number of books in the home variable did not follow a normal distribution, so a Kruskal-Wallis test was used instead of an independent samples t-test. The results showed a significant difference, with students from households with more books demonstrating higher digital literacy levels (see Table 16). Figure 4 illustrates the mean values for SDL1 to SDL5 based on the number of books in the home.

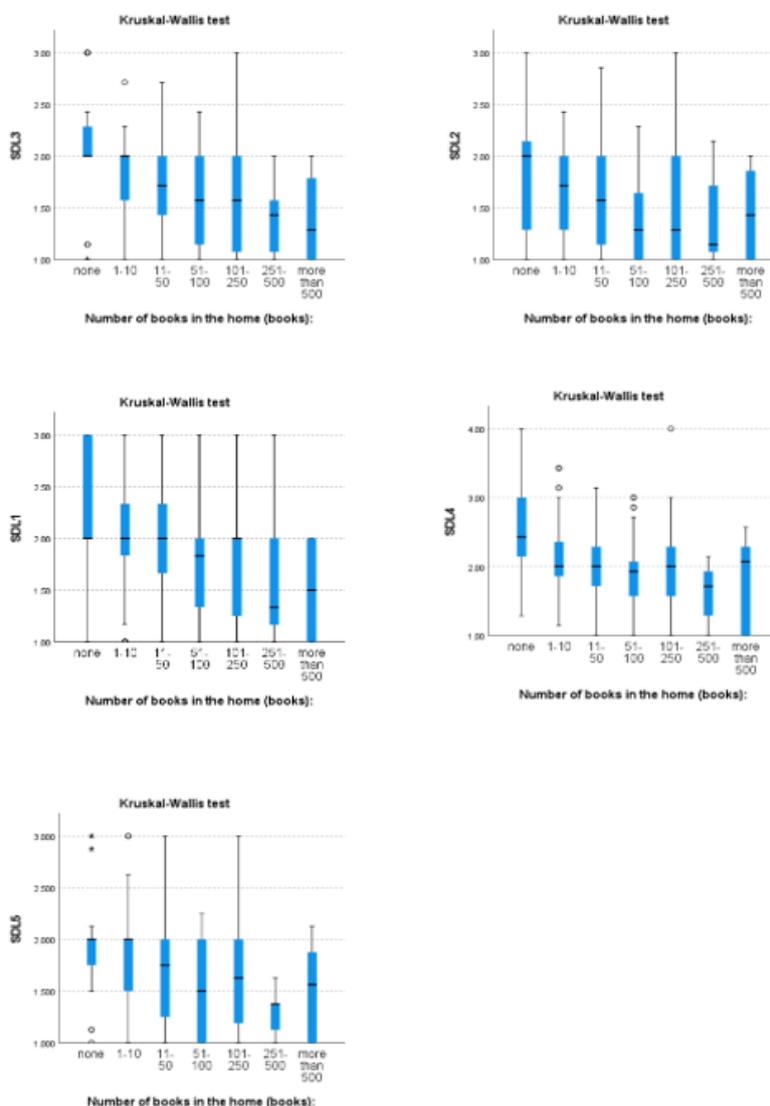


Figure 4: Mean Values in SDL1 to SDL5 Divided by Number of Books in Home

Table 16*Kruskal-Wallis Test Divided by the Number of Books in Home*

Dimensions	P	Decision	None		1-10		11-50		51-100		101-250		251-500		More than 500	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
SDL1	.000***	Reject the null hypothesis	1.9793	0.61433	1.6009	0.47902	1.7243	0.4654	2.0413	0.56335	1.7035	0.46844	1.651	0.54766	1.6575	0.53876
SDL2	.001***	Reject the null hypothesis	1.9814	0.61443	1.4638	0.40376	1.5873	0.40376	1.9101	0.492	1.5864	0.45097	1.6889	0.42792	1.9911	0.42836
SDL3	.000***	Reject the null hypothesis	1.9797	0.4654	1.7104	0.43213	1.8571	0.39157	1.5873	0.43213	1.8571	0.35869	1.5714	0.39157	1.4286	0.42792
SDL4	.000***	Reject the null hypothesis	2.0413	0.56335	2.0235	0.492	2.0235	0.56335	1.9101	0.492	2.0413	0.55618	1.9	0.55618	1.9911	0.54766
SDL5	.000***	Reject the null hypothesis	1.7035	0.46844	1.5864	0.45097	1.75	0.35869	1.5864	0.45097	1.3828	0.37693	1.4286	0.37693	1.25	0.37693

Note: SD = Standard Deviation; * p < 0.05 ** p < 0.01 *** p < 0.001.

Training

A total of 81.8% of students expressed interest in participating in a digital literacy training course (see Table 17). Among the different training methods, project practice was the most preferred, with 333 students opting for this approach. Self-study was the second most popular, preferred by 302 students, followed by training courses, which 278 students favoured (see Table 18).

Table 17

Would You Like to Participate in Training Course on Digital Literacy?

Frequency	Count	Percentage	Valid Percentage	Accumulate Percentage
Yes	327	81.8	81.8	81.8
No	73	18.3	18.3	100.0
Total	400	100.0	100.0	100.0

Table 18

What Do You Think are the Ways to Improve Digital Capabilities?

Ways to Improve Digital Capabilities	Frequency	Number of Cases	Missing
Homework	184	400	0
Project practice	333	400	0
Self-study	302	400	0
Training	287	400	0

Note. Author's own arrangement by using the SPSS 27.0.

Discussion

The research on digital literacy among higher education students in Shandong Province reveals several key findings. While most students demonstrate basic digital competence, significant weaknesses were identified in critical evaluation and information retrieval skills. Educational institutions should prioritise the development of advanced critical thinking skills to address the challenges posed by information overload and source validation in the digital age. The data also indicates that urban students outperform their rural counterparts in terms of digital literacy. To address this disparity, targeted support measures should be implemented in rural areas to enhance digital literacy skills. Additionally, students' digital teaching competencies are influenced by their academic performance and family background. Incorporating digital literacy programs into academic curricula would enhance students' digital skills, as those with higher academic performance tend to possess stronger digital competencies.

Furthermore, most students expressed a strong interest in participating in digital literacy training courses, with project practice and self-study being the most popular approaches. This suggests that students prefer practical learning methods, which foster greater engagement and skill development. Educational institutions should consider integrating hands-on projects and self-study components into digital literacy training programmes to meet students' preferences and improve outcomes. Overall, the study highlights the need for comprehensive strategies in digital literacy education, focusing on

rural student support, effective skills evaluation, and adaptable, practical learning methods.

Conclusion

Enhancing students' digital literacy and nurturing their digital talents is a core objective of the digital transformation in education. The first step is to assess the current state of digital literacy among college students in Shandong Province. The findings of this study are summarised as follows:

Firstly, the overall digital literacy level of college students in Shandong Province is relatively high, with average scores falling between 1.5 and 2 points out of a possible 4. Secondly, the research hypothesis is supported. Hypothesis 1 is fully supported, while Hypothesis 2 is partially supported. The study reveals a noticeable digital divide among higher education students. The region in which students live significantly impacts their digital literacy, confirming findings from [Gumede \(2021\)](#), which show a clear gap between rural and urban students. Educational background also plays a significant role; graduate students generally possess higher digital literacy than undergraduates, except for skills related to information resources.

Thirdly, various personal factors, such as gender, educational background, academic performance, and parental education, have a notable impact on certain aspects of digital literacy. However, these factors do not significantly affect all areas of digital literacy. A key finding is that academic performance is strongly correlated with digital literacy, while factors like screen time and app usage do not show significant differences. This suggests the importance of encouraging students to focus more on academic activities rather than excessive use of electronic devices. Finally, the willingness of students to participate in digital literacy training is notably high, with 81.8% expressing interest in such courses. Additionally, students favour project-based learning and independent study to improve their digital skills, with formal training being a secondary preference. These preferences provide useful insights for curriculum design, highlighting that digital literacy is primarily developed through self-driven efforts, rather than through teacher-directed learning.

The limitations of this study include: (1) a relatively small sample size that may not fully represent the digital literacy of all students due to time and resource constraints, (2) the online survey method, which may exclude students without internet access or those unwilling to participate in online surveys, leading to potential data bias, and (3) insufficient research depth, as the study focuses solely on the impact of individual traits on digital literacy. Future research may explore additional factors such as cultural influences and other socio-economic variables.

Acknowledgements

Thanks to the support and participation of students from 18 universities in Shandong Province, first-hand real data was collected. I would also like to express my special thanks to the tutor for her guidance and the team for their profound discussion and support without reservation. This greatly promotes research. All authors have read and agreed to the published version of the manuscript.

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