Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6, 3962-3970
2024
Publisher: Learning Gate
DOI: 10.55214/25768484.v8i6.2869

Development of digital literacy model for college students in Minzu colleges and universities in Southwest China

Jie Wang[1*], Suttipong Boonphadung[2]
[1,2]Graduate School, Suan Sunandha Rajabhat University, Bangkok, 10300, Thailand; scunjkx@126.com (J.W.).

Abstract: Constructing a digital literacy model for college students in Minzu Colleges and Universities in Southwest China is crucial for advancing the implementation of the "Action Plan for Improving National Digital Literacy and Skills" and effectively conducting digital literacy education. By researching digital literacy models from abroad and employing bibliometric methods, an initial conceptual framework for the digital literacy model for college students was developed. A mixed-methods research approach, combining quantitative and qualitative research, was used. Confirmatory Factor Analysis (CFA) was employed to test the validity and reliability of the initial model, which was then refined based on CFA results and expert feedback. In-depth interviews with experts were conducted to further optimize the model. The resulting digital literacy model for college students in Minzu Colleges and Universities in Southwest China not only holds significant implications for digital literacy education in this region but also provides a reference for constructing digital literacy models for other educational stages and in different regions. This model-building approach can serve as a valuable reference for similar research and practice.

Keywords: *College students, Digital literacy model, Minzu colleges and universities in Southwest China.*

1. Introduction

As early as 2017, LinkedIn's survey report indicated that the most important skills in the job market were all related to emerging technologies (LinkedIn,2021). Over the past decade, as the global digital transformation has deepened, major countries around the world have gradually realized the fundamental role of digital literacy and skills in talent cultivation (Xiao,2021). Whether for an individual's survival or a nation's development, the digital literacy of the new generation of workers is a critical issue worthy of attention.

College students are the primary force in the future construction of the nation and society, as well as potential members of the new generation of the workforce. Consequently, in recent years, there has been an increasing emphasis on cultivating digital competencies and digital literacy education among college students within the field of international education. Scholars have noted that the "Action Plan for Improving National Digital Literacy and Skills," issued by the Central Cyberspace Affairs Commission, may have its most significant impact on the digital literacy education of college students. It is suggested that the enhancement of college students' digital literacy should gradually become a core responsibility and requirement within the field (Xiao & Zhao,2021). Therefore, it is essential to follow the latest trends in digital literacy, study the assessment frameworks and relevant standards for college students' digital literacy, and provide references for formulating scientific training directions, development plans, and implementing effective digital literacy education. Due to economic and regional cultural influences, there are also certain particularities in the digital literacy levels of students from different regions. Research on student digital literacy in China has started relatively late, with even less focus on college students in Minzu colleges and universities in the southwest. Studying the digital literacy model of college students in these universities and assessing their digital literacy levels can provide valuable references for policymakers in developing evaluation methods for college students' digital literacy.

* Correspondence: scunjkx@126.com

2. Literature Review

Researchers have analyzed various international digital literacy frameworks, such as the European Union's Digital Competence Framework (DigComp) (Ferrari,2013), the EU's Digital Competence Framework for Educators (DigCompEdu) (Lan, et al., 2020), UNESCO's Global Framework for Digital Literacy (Zheng, 2019), and the Digital Intelligence (DQ) framework proposed by the Coalition for Digital Intelligence (CDI) (Wang,2021). Additionally, the Netherlands' digital literacy learning framework for primary and secondary students, which integrates the Dutch Digital Strategy and digital literacy reports, is another key focus (Wei,2020). On the other hand, from the perspective of the key actors in digital literacy education, scholars have examined the creation of digital literacy frameworks for specific groups such as librarians (Zhou & Cheng, 2016), primary and secondary school teachers (Wang, 2015), and higher education faculty (Yang & Zhou, 2019). Some scholars have pointed out that "the European Union has already regarded national digital literacy as a crucial factor in global competition, elevating the enhancement of digital literacy to a national strategic priority" (Ren, Sui, & Liu, 2014). Based on this, this paper attempts to review representative digital literacy frameworks, track global trends in digital literacy education, deconstruct the core elements, and, in conjunction with the essential concepts, the characteristics of college students in Minzu colleges and universities in Southwest China, and the practical needs of society, construct a digital literacy framework tailored to local requirements.

Representative international digital literacy model can be broadly divided into two categories: (1) models aimed at the general public, represented by the European Union's DigComp framework; and (2) models specifically targeting student groups, such as the New Media Consortium (NMC) Higher Education Digital Literacy Framework in the United States and the International Society for Technology in Education (ISTE) Student Standards (2016).

2.1. Digital Literacy Framework for the General Public

Digital literacy models or indicator systems designed for the general public tend to have a strong degree of universality. Among the most representative of these are the DigComp and DQ digital literacy framework.

The DigComp framework, proposed by the European Union in 2013, has undergone two updates and revisions, with the most recent version being DigComp 2.2, published in 2022. This framework divides digital competence into five areas: "Information and Data Literacy," "Communication and Collaboration," "Digital Content Creation," "Safety," and "Problem Solving." It encompasses 21 specific competencies, each with requirements across three dimensions: knowledge, skills, and attitudes. The framework also categorizes competency levels into eight stage (Vuorikari, Kluzer, & Punie, 2022). Additionally, it identifies 259 examples aimed at helping European citizens use digital technologies confidently, critically, and safely.

The DQ digital literacy framework, proposed in 2019, includes eight competency domains: "Digital Identity," "Digital Usage," "Digital Safety," "Digital Security," "Digital Emotional Intelligence," "Digital Communication," "Digital Literacy," and "Digital Rights." Each domain is divided into three progressive dimensions: "Digital Citizenship," "Digital Creativity," and "Digital Competitiveness" (DQ Institute,2019).

In comparison, the DigComp framework is more representative. On one hand, there are many overlapping elements between DigComp and the DQ digital literacy frameworks, but DigComp covers important and fundamental digital competencies. On the other hand, DigComp integrates concepts such as information literacy, media literacy, and digital literacy, defining the concept of digital literacy based on 15 representative digital literacy frameworks and has successfully passed expert validation and verification (Ferrari, 2013). Therefore, DigComp has received widespread recognition and application in both industry and academia. In 2018, UNESCO, building on DigComp 2.0, added two new domains: "Device and Software Operation" and "Job-Related Competencies," and introduced the "Computational Thinking" indicator into the "Problem Solving" domain, publishing the *Digital Literacy Global Framework (DLGF)* (UNESCO,2018).

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869

2.2. Digital Literacy Frameworks Specifically for Students

Among the digital literacy frameworks specifically designed for students, especially at the university level, notable examples include the NMC Higher Education Digital Literacy Framework, the P21 (Partnership for 21st Century Skills) model from the United States, and the ISTE (International Society for Technology in Education) Student Standards.

In 2017, the NMC highlighted in *Digital Literacy in Higher Education, Part 2: Horizon Report Strategic Brief* that representative digital literacy frameworks commonly encompass elements such as communication, critical thinking, technological skills, content creation, digital citizenship, and copyright law (Alexander, Becker, Cummins, & Giesinger, 2017).

The NMC argues that digital literacy in higher education should encompass both technical skills (such as web searching, digital production tools, coding, and hardware skills) and socio-cultural skills (such as critical thinking, interpersonal communication, copyright knowledge, and digital citizenship) (Alexander, Becker, Cummins, & Giesinger, 2017). The NMC framework categorizes digital literacy into three dimensions: general literacy, innovation literacy, and interdisciplinary literacy. General literacy represents the basic competencies students should master for practical work, innovation literacy builds on general literacy to enhance learners' creative abilities, and interdisciplinary literacy refers to integrating digital skills across various disciplines and learning contexts (Alexander, Becker, Cummins, & Giesinger, 2017). The NMC framework emphasizes embedding digital literacy education into subject-specific curricula in addition to school libraries.

The P21 model, introduced in 2002, posits that essential 21st-century skills for students include core subject knowledge and foundational skills, learning and innovation skills, information, media, and technology skills, and life and career skills (Battelle for Kids,2021). Beyond mastering information and media skills, the P21 model focuses on students' ability to quickly learn and adapt to new environments.

In 2016, the International Society for Technology in Education (ISTE) introduced national standards for measuring students' digital skill development, known as the ISTE Student Standards. These standards require students to fulfill seven roles: "Empowered Learners," "Digital Citizens," "Knowledge Constructors," "Innovative Designers," "Computational Thinkers," "Creative Communicators," and "Global Collaborators" (ISTE,2016).

3. Methods and Materials

This section describes the methods used by the researchers to retrieve literature, collect, and analyze data in order to construct a digital literacy model for university students in Minzu colleges and Universities in Southwest China.

This study employs a mixed-methods research design, combining both quantitative and qualitative research approaches. The research process is divided into the following steps: 1) identifying the research topic and formulating research questions; 2) conducting a literature review and expert interviews to establish the theoretical framework; 3) developing research instruments; 4) collecting research data; 5) organizing and analyzing the data; and 6) validating and refining the model.

In the first step, the research topic was identified as "Development of Digital Literacy Model for College Students in Minzu Colleges and Universities in Southwest China."

In the second step, the researchers reviewed domestic and international literature, sourcing articles from a variety of platforms. The selected literature focused on "digital literacy" and included academic papers, research reports, and government policies. The subjects discussed in these materials ranged from citizens and students to educators. Based on a comprehensive review, the researchers summarized the digital literacy models for university students and then invited five experts to evaluate these models, forming the conceptual framework.

In the third step, A questionnaire was developed based on the theoretical framework, and the IOC (Index of Item-Objective Congruence) was used with expert input to ensure validity. A pilot study was conducted, and adjustments to the questionnaire were made based on the KMO (Kaiser-Meyer-Olkin) value and Bartlett's Test of Sphericity (where a significance level < 0.5 indicates correlation between

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869

variables). The final questionnaire contained six latent factors, 25 observed factors, and 75 items. A qualitative interview guide was also developed in line with these factors.

For the main data collection, the formal survey was administered via the "WEN JUAN XING" platform, targeting five ethnic colleges in Southwest China (Southwest Minzu University, Yunnan Minzu University, Guizhou Minzu University, Tibet Minzu University, and Sichuan Minzu College). A total of 625 responses were collected, and after excluding 14 invalid responses, 601 valid questionnaires were retained for analysis. The qualitative study involved interviews with nine experts in educational technology, higher education, and library science, as well as administrators from Minzu colleges in Southwest China.

Data were analyzed using SPSS 26.0. After conducting reliability and validity analyses on the questionnaire data, confirmatory factor analysis (CFA) was performed using AMOS 24.0, a structural equation modeling (SEM) software. The study applied a second-order confirmatory factor analysis with six first-order latent variables (knowledge and skills, information and data, communication and collaboration, content creation, security and privacy, and problem-solving) and one second-order latent variable (digital literacy). The model included 25 observed variables and 25 error variables. Maximum likelihood estimation was employed to assess the fit of the empirical data to the theoretical model.

Finally, the quantitative and qualitative research data were analyzed together, leading to the development of digital literacy model for College Students in Minzu Colleges and Universities in Southwest China. This model serves as a reference for evaluating and improving digital literacy among university students in ethnic colleges in the region.

4. Results

In this study, six first-order latent variables were established: Knowledge and Skills, Information and Data, Communication and Collaboration, Content Creation, Safety and Privacy, and Problem-Solving. Digital Literacy was set as the second-order latent variable in the higher-order measurement model. The model included 25 observed variables and 25 residual variables. The maximum likelihood estimation method was used to run the model, examining the degree to which empirical data supported the theoretical model. The results are shown in the figure.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869

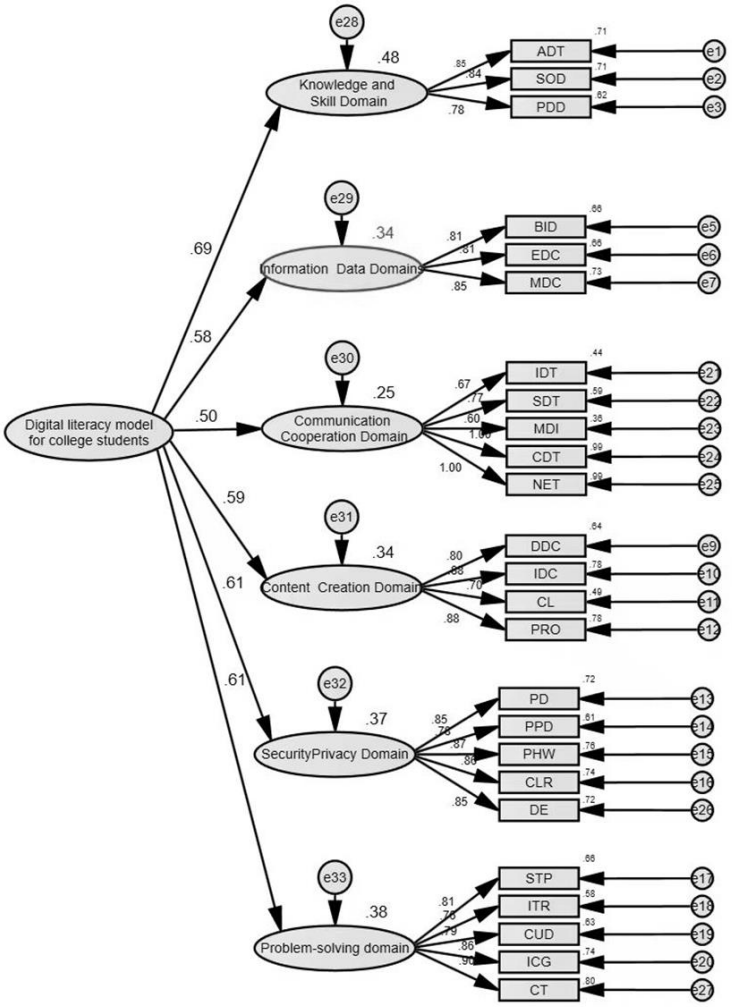

Figure 1.
The model of confirmatory factor analysis.

Based on the Figure 1, the factor loadings for knowledge and skills, information and data, security and privacy, and problem-solving are all above 0.76, indicating a strong and significant relationship between these factors and their respective latent variables. Additionally, the factor loadings for communication and collaboration, as well as content creation, are all above 0.6. Although slightly lower than the other dimensions, these values are still within an acceptable range. Overall, the factor loadings across all dimensions are ideal, reflecting the effectiveness of the observed variables in measuring their corresponding latent constructs in the context of digital literacy.

Additionally, multiple model fit indices such as chi-square/df (χ^2/df), Root Mean Square Error of Approximation (RMSEA), Incremental Fit Index (IFI), Comparative Fit Index (CFI), Parsimony Goodness of Fit Index (PGFI), Normed Fit Index (PNFI), and Comparative Fit Index (PCFI) were used to assess the structural validity of the scale, as shown in Table 1. According to the acceptable thresholds for these indices, the model fit essentially meets the testing requirements.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869

Table 1.
Confirmatory factor analysis model fit.

Model fit coefficient	$\chi 2/df$	RMSER	IFI	CFI	PGFI	PNFI	PCFI
Optimal standard value	<3.0	<0.08	>0.90	>0.90	>0.50	>0.50	>0.50
Statistical value	2.597	0.052	0.964	0.964	0.753	0.845	0.864
Fit	Good	Good	Good	Good	Good	Good	Good

From Table 1, it is evident that the model structure effectively explains the data, indicating that the hypothesized latent variables and their interrelationships are reasonable. The PGFI/PNFI and PCFI values are all above 0.50, suggesting that the model maintains a high fit while effectively controlling the number of parameters, thus avoiding overfitting. This reflects the model's good parsimony. The model adequately explains the observed variables across various dimensions. In summary, the digital literacy model for college students in Minzu colleges and universities in Southwest China, as developed in this study, demonstrates strong structural validity, maintains high parsimony, and exhibits a reasonable fit, making it a valuable reference for both research and practical applications.

Table 2.
Convergent validity.

Latent factor	Observation factor	Factor loads	CR	AVE
Knowledge and skills	ADT	0.845	0.865	0.681
	SOD	0.845		
	PDD	0.785		
Information and data	BID	0.812	0.866	0.683
	EDC	0.814		
	MDC	0.852		
Communication and cooperation	IDT	0.882	0.934	0.744
	SDT	0.770		
	MDI	0.604		
	CDT	0.996		
	NET	0.995		
Content creation	DDC	0.799	0.886	0.662
	IDC	0.862		
	CL	0.699		
	PRO	0.883		
Security and privacy	PD	0.850	0.924	0.709
	PPD	0.780		
	PHW	0.872		
	CLR	0.857		
	DE	0.848		
Problem-solving	STP	0.813	0.892	0.790
	ITR	0.763		
	CUD	0.795		
	ICG	0.896		
	CT	0.666		

Convergent validity primarily assesses the correlation among different measurement items within each latent variable. It is typically measured using factor loadings, composite reliability (CR), and average variance extracted (AVE). For good convergent validity, standardized factor loadings should be greater than 0.5, CR should be greater than 0.7, and AVE should be greater than 0.5.The results in

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869

Table 2 indicate that the standardized factor loadings for the measurement items of each latent variable range from 0.604 to 0.996, all of which are above 0.5, with the majority being above 0.8. Composite reliability values range from 0.865 to 0.934, all exceeding 0.7. Average variance extracted values range from 0.662 to 0.790, all above 0.5. These results suggest that the six latent variables in this study have good convergent validity.

Table 3.
Discriminant validity.

	Knowledge & skills	Information data	Communication collaboration	Content creation	Security privacy	Problem -solving
Knowledge & skills	0.825					
Information & data	0.305	0.826				
Communication& collaboration	0.407	0.335	0.863			
Content creation	0.421	0.310	0.373	0.814		
Security & privacy	0.422	0.309	0.270	0.300	0.842	
Problem-solving	0.371	0.379	0.301	0.285	0.424	0.889

Discriminant validity primarily measures the degree of distinction between different variables. It is assessed by comparing the square roots of the average variance extracted (AVE) with the correlations between variables. If the square root of the AVE for each variable is greater than the correlations between that variable and others, it indicates that the measurement scale has good discriminant validity.

According to Table 3, the square roots of the AVE (bold numbers on the diagonal) for each variable are greater than the correlations with other variables in the same row and column. This suggests that the measurement scale exhibits good discriminant validity. The latent variables show both meaningful relationships and appropriate distinctions, with no overlap or confusion among the concepts represented by different latent variables. This result supports the discriminant validity of the digital literacy model for college students in Minzu colleges and universities in Southwest China.

5. Conclusion and Suggestions

After conducting confirmatory factor analysis, this study invited experts in related fields and administrators from Minzu colleges and universities in Southwest China to participate in interviews, perform qualitative analyses, and refine the model. All nine interviewees agreed with the overall latent and observed factors of the model, while also offering suggestions for improvement, such as emphasizing the connotations of "cross-cultural adaptation" and "digital governance." After careful consideration, the researcher refined these concepts and ultimately proposed a digital literacy model for college students in Minzu colleges and universities in Southwest China.

The final model consists of six factors: knowledge and skills, information and data, communication and collaboration, content creation, security and privacy, and problem solving. Each factor includes several observed variables, encompassing a wide range of competencies, from basic digital skills to advanced applications and critical thinking, as illustrated in Figure 2.

This study also offers recommendations for promoting and applying the model. Relevant institutions should develop comprehensive educational programs on digital literacy, deeply integrate digital literacy cultivation with educational practices, strengthen the construction of general education and relevant professional curricula, enhance the digital campus culture, improve teacher training for digital literacy, and emphasize cross-cultural digital education and digital ethics. These suggestions aim to elevate the digital literacy levels of college students in Minzu colleges and universities in Southwest China, providing a valuable reference for future digital literacy education efforts in the region.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869

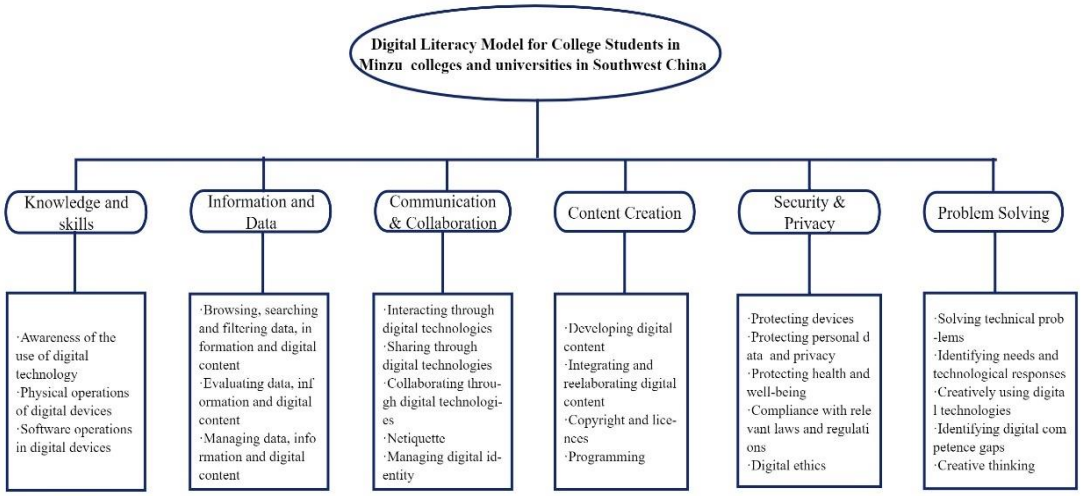

Figure 2.
Digital literacy model for college students in Minzu Colleges and Universities in Southwest China.

Firstly, administrators of Minzu colleges and universities in Southwest China should place a high priority on digital literacy education for students. Given the competitive higher education environment, these institutions must fully recognize the importance of cultivating digital literacy among students, enhancing their competencies across the dimensions of knowledge and skills, information and data, communication and cooperation, content creation, security and privacy, and problem-solving. To begin with, a comprehensive digital literacy development program should be established, focusing on the construction of general digital literacy courses. Furthermore, efforts should be made to foster a digital learning and innovation culture on campus. The development of digital and smart campuses can provide students with a conducive digital learning environment, promoting habits of digital learning and innovation. Thirdly, the digital literacy of faculty should be improved, making it a key component of various teacher training programs. Fourthly, teachers should integrate digital literacy education organically into their teaching practices. Lastly, educators and administrators should emphasize digital ethics education, helping students to develop a scientific understanding of digital technology, especially fostering correct digital values.

References
[1] Alexander, B., Becker, S. A., Cummins, M., & Giesinger, C. H. (2017). *Digital literacy in higher education, Part II: An NMC Horizon project strategic brief* (pp. 1-37). The New Media Consortium.
[2] Battelle for Kids. (2021). *Frameworks & resources* [Electronic resource]. Retrieved from https://www.battelleforkids.org/networks/p21/frameworks-resources.
[3] ISTE. (2016). ISTE standards for students. Retrieved from https://iste.org/standards/students.
[4] Alexander, B., Becker, S. A., Cummins, M., & Giesinger, C. H. (2017). Digital literacy in higher education, Part II: An NMC Horizon project strategic brief (pp. 1-37). The New Media Consortium.
[5] Battelle for Kids. (2021). Frameworks & resources [Electronic resource]. Retrieved from https://www.battelleforkids.org/networks/p21/frameworks-resources.
[6] DQ Institute. (2019). DQ global standards report 2019: Common framework for digital literacy, skills and readiness [Report/Online]. Retrieved from https://www.dqinstitute.org/wp-content/uploads/2019/03/DQGlobalStandardsReport2019.pdf
[7] Ferrari, A. (2013). DIGCOMP: A framework for developing and understanding digital competence in Europe [Report/Online]. Luxembourg: European Union. Retrieved from https://publications.jrc.ec.europa.eu/repository/handle/JRC83167

[8] Guo, Y. G. (2017). The EU Digital Competence Framework DigComp 2.1: Analysis and implications. Digital Education, 3(5), 10-14.
[9] ISTE. (2016). ISTE standards for students. Retrieved from https://iste.org/standards/students.
[10] Lan, G. S., Guo, Q., Zhang, Y., et al. (2020). The EU Digital Competence Framework for Educators: Key points and implications. Modern Distance Education Research, 32(6), 23-32.
[11] LinkedIn. (2021, August 10). The top skills that can get you hired today and tomorrow [Report/Online]. Retrieved from https://www.linkedin.com/business/talent/blog/talent-strategy/skills-you-will-be-hiring-for
[12] Ren, Y. Q., Sui, X. X., & Liu, X. Y. (2014). Research on the EU Digital Literacy Framework. Modern Distance Education Research, (5), 3-12.
[13] UNESCO. (2018). A global framework of reference on digital literacy skills for Indicator 4.4.2. Retrieved from https://uis.unesco.org/sites/default/files/documents/ip51-global-framework-reference-digital-literacy-skills-2018-en.pdf
[14] Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The digital competence framework for citizens. With new examples of knowledge, skills and attitudes. Retrieved from https://op.europa.eu/en/publication-detail/-/publication/50c53c01-abeb-11ec-83e1-01aa75ed71a1/language-en.
[15] Wang, J. (2015). Design and implementation of a digital literacy evaluation system for primary and secondary school teachers [Master's thesis, Central China Normal University].
[16] Wang, X. Y. (2021). The global standards framework for future digital literacy and competence: An analysis based on the "2019 DQ Global Standards Report." Library Construction, 309(3), 173-180, 185.
[17] Wei, X. M. (2020). The digital literacy learning framework and implementation path for primary and secondary students in the Netherlands. Comparative Education Research, 42(12), 71-77.
[18] Xiao, P. (2021). Introduction to the special issue: China's actions and international experiences in improving digital literacy and skills. Journal of Agricultural Library and Information, 33(12), 4-5.
[19] Xiao, P., & Zhao, Q. X. (2021). The road to becoming a strong country in digital talent: The "Action Plan for Improving National Digital Literacy and Skills" and strategies for digital literacy education among college students. Journal of Agricultural Library and Information, 33(12), 6-15.
[20] Yang, S., & Zhou, Z. Q. (2019). Research on the construction of digital literacy evaluation indicators for university teachers. Modern Information, 39(3), 59-68, 100.
[21] Zheng, C. H. (2019). UNESCO's Global Framework for Digital Literacy: Background, content, and implications. Foreign Primary and Secondary Education, (9), 1-9.
[22] Zhou, F. F., & Cheng, C. (2016). Discussion on the evaluation of digital competence of university librarians. Modern Business Trade Industry, 37(19), 93-96.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 8, No. 6: 3962-3970, 2024
DOI: 10.55214/25768484.v8i6.2869