

An International Modified Delphi Study on Validating the Concept and Components of Digital Literacy

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Abstract

This study aims to systematically conceptualize and validate a comprehensive digital literacy (DL) framework through an international modified Delphi process. In the field of technology education, DL has been defined in diverse ways by scholars worldwide, highlighting the growing need for a shared and consensus-based understanding at the global level. To address this issue, the study systematically analyzed prior research conducted worldwide since 1995 to derive an initial conceptual framework of DL. Subsequently, three rounds of Delphi surveys were conducted with experts from South Korea's academia and school sectors to refine the framework, followed by two rounds of international Delphi surveys with 14 experts from four continents—Asia, Europe, Africa, and the Americas—to examine cross-cultural validity.

The final outcome of this study presents a DL framework supported by cross-cultural expert review, comprising six interrelated components organized across developmental stages (basic–intermediate–advanced): technological competence; digital content understanding, search and evaluation; digital content application and creation; digital communication; computational thinking (CT)-based problem solving; and social contribution and ethical responsibility. Each component is further specified through a total of 64 subcomponents, systematically articulated to reflect developmental progression and educational applicability. This framework clarifies the concept of DL within technology education and offers an internationally applicable standard for curriculum design, assessment, and policy development across diverse educational contexts.

South Korea demonstrates a high level of information and communication technology (ICT) capacity, and digital transformation is rapidly advancing across industries, including education. In particular, technology education is closely linked to this digital shift. By integrating international expert perspectives into a framework initially shaped by the insights of South Korean researchers, this study broadens understanding of DL by incorporating multi-perspective insights and deepens international connectivity and mutual understanding in technology education, thereby informing ongoing global discourse in technology education.

1 INTRODUCTION

As digital technologies permeate all areas of modern life, digital literacy (DL) has become a core competency for citizens globally. Governments, educational institutions, and international organizations increasingly regard DL as essential for learning, problem-solving, and participation in a rapidly changing society. South Korea, for example, has integrated DL across the national curriculum and introduced new elective subjects to strengthen students' digital and analytical abilities. Beginning in 2025, AI-based digital textbooks have been introduced as instructional materials in South Korea, reflecting the expanding role of DL in education. Similar developments appear worldwide: Canada's MediaSmarts (2015) emphasizes critically engaging with digital media; the European Commission (2018) highlights the need to reinforce digital competence; and OECD positions DL as foundational for future learning. Collectively, these initiatives demonstrate a shared recognition of DL as an indispensable competency in the digital age.

Despite this widespread attention, DL remains inconsistently defined. Since its early conceptualizations by Lanham (1995) and Gilster (1997), the field has expanded to encompass cognitive, technical, socio-emotional, communicative, and ethical dimensions. Influential frameworks and theoretical perspectives—including the European Commission's DigComp framework (2018), UNESCO's Digital Literacy Global Framework (2018, 2019), conceptual models proposed by Eshet-Alkalai (2002, 2004), critical perspectives articulated by Buckingham (2003, 2015), and institutional frameworks developed by JISC (2011, 2014)—offer diverse perspectives, yet the lack of unified terminology and structure contributes to conceptual fragmentation. Cultural and contextual differences among countries further complicate the establishment of a common global understanding.

In response, this study aims to construct and cross-culturally validate a digital literacy framework through a modified Delphi process. The guiding research questions were:

- (i) How was the DL framework constructed through the South Korean Delphi study?
- (ii) To what extent is the framework validated by international experts?
- (iii) What cross-cultural differences emerge?

2 THEORETICAL BACKGROUND

2.1 The Concept of Literacy

The concept of literacy has evolved from its original meaning—the ability to read and write—to a multidimensional construct shaped by social, cultural, and technological change. From the perspective of New Literacy Studies, literacy is understood not merely as a set of technical skills

but as a form of social practice embedded in particular contexts and enacted through participation, communication, and meaning-making (Street, 1984; Barton & Hamilton, 1998). The multiliteracies framework further expanded this view by emphasizing multimodality, collaboration, and the production of knowledge across diverse media environments (New London Group, 1996; Cope & Kalantzis, 2009). In contemporary digitally mediated societies, literacy therefore involves not only accessing and understanding information but also creating, communicating, and participating as responsible members of a community, which connects literacy to the ethical and civic dimensions highlighted in discussions of digital citizenship (Ribble, 2015; Choi, 2016).

These theoretical developments also point to a conceptual distinction between competence and literacy. While competence-based approaches tend to focus on functional and measurable performance, literacy-oriented perspectives stress socially situated meaning-making, critical engagement, and transformative participation (Biesta, 2009; Lankshear & Knobel, 2008). From this standpoint, DL can be conceptualized as a holistic and context-sensitive construct that integrates technological, cognitive, and socio-cultural dimensions rather than as a collection of discrete technical skills. This literacy-oriented perspective provides the theoretical basis for structuring the proposed digital literacy framework in relation to technology education.

2.2 *The Concept and Components of Digital Literacy*

DL has been conceptualized from multiple perspectives. Early studies emphasized the ability to interpret digital information and use digital tools effectively (Lanham, 1995; Gilster, 1997), while later work expanded the concept to include multimodal understanding, critical evaluation of information, online collaboration, and ethical awareness (Eshet, 2004; Hobbs, 2010; Rheingold, 2012). Institutional frameworks such as DigComp (European Commission, 2018) and UNESCO's Digital Literacy Global Framework (2018, 2019) further structured DL as a set of interrelated competence areas, including information and data literacy, content creation, communication and collaboration, safety, and problem solving. In order to identify the core domains of DL, this study conducted a comparative analysis of twelve major prior studies and frameworks. Each framework was examined using a common analytical scheme, focusing on the competence areas and conceptual domains proposed in the literature. Despite differences in terminology and emphasis, six recurring domains were consistently identified: the use of digital technologies, understanding and handling digital information and content, communication and collaboration, creative production, problem solving, and ethical and social responsibility.

Based on this synthesis, the present study reorganizes these recurring domains into six components and reinterprets them from the perspective of technology education. Technological competence reflects the technological capability emphasized in the field, while digital content understanding, search, and evaluation represents the cognitive and critical dimension of DL. Digital content application and creation highlights productive participation in digital environments, and digital communication emphasizes collaborative and socio-emotional interaction. CT-based problem solving was included to align DL with the design-oriented and problem-solving tradition of technology education, and social contribution and ethical responsibility extends DL toward digital citizenship. This synthesis provides the theoretical basis

for the development of the DL framework and conceptualizes DL as a multidimensional structure prepared for cross-cultural validation.

Table 1 illustrates the convergence of domains identified across twelve prior studies on digital literacy. The six core components proposed in this study were synthesized based on these recurring conceptual domains.

Table 1

Comparison of Core Domains Derived from Prior Studies on DL

Prior Studies	Technological Competence	Digital Content Understanding, Search, and Evaluation	Digital Content Application and Creation	Digital Communication	CT-based Problem Solving	Social Contribution and Ethical Responsibility
ALA (2011)	x		x	x	x	x
Buckingham (2003)	x	x	x	x	x	x
Belshaw (2014)	x		x	x	x	x
Eshet-Alkalai (2004, 2005)		x	x	x	x	
European Commission (2018)	x	x	x	x	x	x
Rheingold (2010)	x		x	x		
JISC (2011–2013)	x	x	x	x	x	x
Martin (2008)		x	x	x	x	x
MediaSmarts (2015)	x	x	x	x	x	x
Gilster (1997)	x	x	x			
Hobbs (2010)	x		x	x	x	x
UNESCO (2018)	x	x	x	x	x	x

3 METHODS

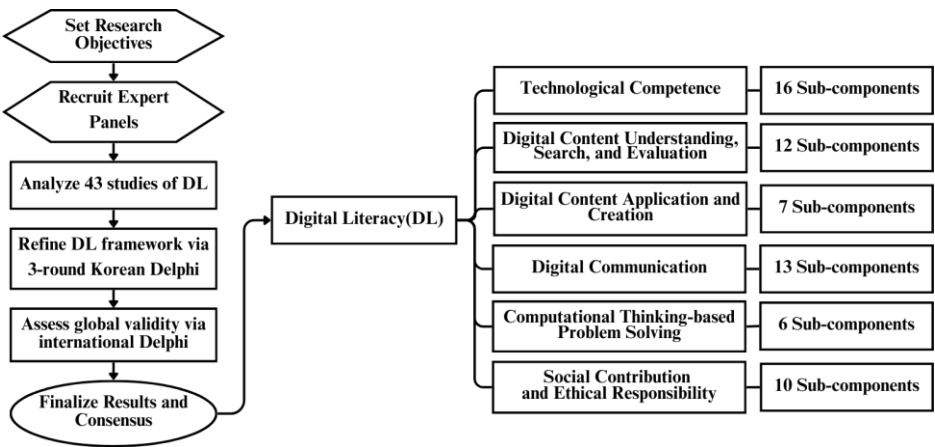
3.1 Research Design

This study adopted a modified Delphi design (Murry & Hammons, 1995) comprising three rounds of a South Korean Delphi study, followed by two rounds of international Delphi review. The overall purpose was to construct a contemporary framework for the concept and components of DL and to validate its relevance through iterative expert consensus.

To achieve this objective, the research was conducted in three sequential stages, as illustrated in Figure 1. Through the procedures outlined in Figure 1, the study proceeded in three stages: (1) identification of preliminary DL components through a review of prior studies, (2) refinement through a three-round Delphi study with South Korean experts, and (3) cross-cultural validation through a two-round international Delphi process.

Figure 1

Research Model



3.2 Expert Selection Criteria

Experts were selected following established Delphi methodological guidelines emphasizing expertise, scholarly recognition, and contextual diversity (Okoli & Pawlowski, 2004; Hsu & Sandford, 2007; Skulmoski et al., 2007; Keeney et al., 2011). To operationalize these guidelines, potential experts were identified from publicly available editorial and reviewer boards of peer-

reviewed international journals in education and educational technology and subsequently screened using publicly accessible institutional profiles, curriculum vitae, and publication records.

Candidates were required to meet the predefined eligibility criteria summarized in Table 2, including a doctoral degree in a relevant field, demonstrated scholarly contributions in digital literacy or closely related areas, and substantial professional or academic experience. Academic rank and institutional affiliation were verified through official university or research institute websites, while practitioner expertise was confirmed through documented involvement in digital literacy or ICT education. Only individuals who satisfied all criteria were invited to participate in the Delphi panel. The detailed selection criteria are presented in Table 2.

Table 2
Selection Criteria for the International Delphi Panel

Criteria	Description
Expertise	Doctoral degree in education, computer education, technology education, or educational policy
	Demonstrated research achievements in DL, AI education, CT, EdTech, or technology-enhanced learning.
Academic Position & Recognition	Faculty members at the rank of assistant professor or higher, or senior researchers.
	Experienced practitioners (e.g., school teachers with experience in DL or ICT education)
International Representation	Experts from global regions.
	Ensured cross-cultural perspectives on DL conceptualization.

3.3 *Panel Composition and Recruitment*

The South Korean Delphi panel consisted of 10 experts from academia and school-based digital education. The international panel ultimately comprised 14 experts representing four continents: Asia, Europe, Africa, and the Americas.

To recruit experts who met the predefined selection criteria, a systematic process was conducted between January 26 and July 29, 2025. The second-round Delphi survey began on August 22, 2025. Five of the original participants responded, and after limited replies despite reminders, additional recruitment was carried out between October 14 and 27. In total, 14 experts who met all selection criteria participated across both rounds, ensuring an internationally diverse and credible Delphi panel.

Table 3

International Delphi Panel by Round

Round	Participants	Withdrawn	Newly Added	Country (Region) Distribution	Major Fields of Expertise
1st Round	10	-	-	Ethiopia, South Africa, Georgia, Spain, Malawi, Singapore, Kyrgyzstan, Saudi Arabia, Italy, Netherlands	Education, Educational Policy, Mathematics Education, Cognitive Science, ICT
2nd Round	9	5	4	Georgia, Netherlands, Spain, Italy, Singapore, Czechia, United States	Education, Technology Education, Computer Science, Mathematics Education

3.4 Data Collection & Analysis

Data analysis procedures are summarized in Table 4, including criteria for the Content Validity Ratio (CVR), which was calculated using Lawshe’s (1975) method based on Schipper’s minimum acceptable values. Consensus indicators included Standard Deviation (*SD*), Interquartile Range (*IQR*), and agreement rate, and sensitivity analysis was conducted using changes in mean (Δ Mean) and standard deviation (Δ *SD*) to examine stability between rounds (Keeney et al., 2011; von der Gracht, 2012).

3.5 AI disclosure

Artificial Intelligence (AI) technologies (e.g., chat GPT) were used solely to enhance clarity and structure of the written text. All scholarly contributions, theoretical perspectives, and analyses were produced by the authors.

Table 4

Summary of Data Collection and Analysis Procedures

Category	Description
Rating Scale	5-point Likert scale (1 = Completely inappropriate → 5 = Highly appropriate).
CVR Criteria	Minimum values: 0.62 (n=10); 0.78 (n=9).
Consensus Indicators	Mean, <i>SD</i> , <i>IQR</i> , Agreement Rate. $SD \leq 1.0$, $IQR \leq 1.0$, Agreement $\geq 75\%$
Sensitivity Indicators	Δ Mean, Δ SD applied to identical items. Δ Mean = $ \text{Mean}_2 - \text{Mean}_1 $ Δ Mean < 0.5 (Stable), 0.5–1.0 (Slight change), ≥ 1.0 (Significant change)

4 RESULTS

4.1 Final Concept and Components of Digital Literacy

Through three rounds of the South Korean Delphi process and two rounds of the international Delphi review, the DL concept and six-component framework were supported through expert agreement. The South Korean experts demonstrated strong agreement on the DL concept and components, and international experts similarly confirmed their global relevance. Although the component related to computational thinking (CT)-based problem solving showed relatively lower agreement among some international participants, the final framework—revised into a developmental structure of Basic, Intermediate, and Advanced levels—reflects cross-cultural feedback and represents the finalized version derived through this multi-stage Delphi process.

Table 5

Final Concept and Six Components of DL

Category	Content
Concept of DL	Digital literacy refers to the ability of individuals, as digital citizens, to effectively understand, utilize, and communicate various technologies and content necessary in the digital age to solve diverse problems in everyday life.
Technological Competence	The ability to understand and use various digital technologies to solve problems.
Digital Content Understanding, Search, and Evaluation	The ability to understand various content in digital environments, devise search strategies, and critically evaluate the results obtained.
Digital Content Application and Creation	The ability to creatively use and produce various digital content.
Digital Communication	The ability to collaborate and communicate within society and communities by utilizing digital content and technologies.
CT-based Problem Solving	The ability to logically solve real-life problems using CT.
Social Contribution and Ethical Responsibility	The ability to understand and adhere to social contributions and ethical responsibilities as a digital citizen.

Han-ul Jang. (2024). A Study on Development of Concept and Components of Digital Literacy using Modified Delphi Techniques. p. 144.

4.2 *Validation of the Finalized Framework of DL*

Table 6 presents the validity results for the DL concept, its six components, and the revised developmental framework. The South Korean Delphi panel demonstrated high levels of agreement across all elements, with CVR values ranging from 0.80 to 1.00. International Delphi Round 1 showed similarly high agreement for most components, although “CT–Based Problem Solving” received a comparatively lower CVR value (0.40). Analysis of the international experts’ open-ended responses indicated that this component was perceived by some panellists as a context-specific competency rather than a universally applicable DL skill.

Based on expert feedback, the DL framework was reorganized into a developmental structure consisting of Basic, Intermediate, and Advanced levels. In the second round of the international Delphi, the revised developmental DL framework was evaluated as a whole, yielding a CVR of 1.00 and a mean score of 4.70 (SD = 0.50).

Table 6*Validation Results of DL Concept, Components, and Revised Framework*

Category	South Korean Delphi(3 rd)		International Delphi(1 st)		International Delphi(2 nd)	
	CVR	Mean (SD)	CVR	Mean (SD)	CVR	Mean (SD)
Concept of DL	1.00	4.70 (0.48)	1.00	4.50 (0.53)	-	-
Technological Competence	0.80	4.50 (0.71)	1.00	4.40 (0.52)		
Digital Content Understanding, Search, and Evaluation	1.00	4.60 (0.52)	1.00	4.50 (0.53)		
Digital Content Application and Creation	1.00	4.70 (0.48)	1.00	4.50 (0.53)	-	(Framework-level only)
Digital Communication	1.00	4.60 (0.52)	0.80	4.40 (0.97)		
CT-based Problem Solving	0.80	4.40 (0.70)	0.40	4.10 (0.88)		
Social Contribution and Ethical Responsibility	0.80	4.50 (0.97)	0.80	4.50 (0.71)		
Revised DL Framework (Basic-Intermediate- Advanced)	-	-	-	-	1	4.70 (0.50)

Table 7 summarizes the aggregated validity statistics for the subcomponents across the six DL components. As shown, the number of subcomponents changed from the first to the second Delphi draft (69 → 64) due to systematic revisions made during the restructuring of the framework. These changes resulted from multiple refinement procedures, including clarification of ambiguous statements, consolidation of overlapping items, deletion of subcomponents with consistently low CVR values, reorganization into developmental levels (Basic–Intermediate–Advanced), and conceptual refinement to ensure cross-cultural coherence. Consequently, some components saw reductions in the number of subcomponents (e.g., CT-based problem solving), while others expanded (e.g., digital communication), reflecting a more balanced and educationally applicable structure.

Across components, the South Korean Delphi panel demonstrated consistently high validity (CVR range = 0.80–1.00; mean ≈ 4.73). In contrast, the first round of the international Delphi

exhibited greater variability in validity ratings (CVR range = 0.00–1.00), with particularly lower values observed for the CT-based problem-solving component. In the second round, the reorganized developmental framework received consistently high evaluations across components.

Notably, eight subcomponents in the second-round international Delphi did not meet the minimum CVR threshold. Rather than viewing these results as deficiencies, they indicate meaningful cross-cultural variations in how certain DL competencies are interpreted. The eight items are currently undergoing qualitative analysis based on experts’ open-ended comments. Drawing on these insights, revisions will be made—such as refining terminology, adjusting categorization, or recalibrating specificity—before conducting a follow-up Delphi round. Through this iterative process, the framework is expected to achieve stronger international applicability and enhanced educational validity.

Table 7

Aggregated Statistics for Subcomponents by DL Component

DL Component	No. of Sub-components 1 st → 2 nd	South Korean Delphi(3 rd)		International Delphi(1 st)		International Delphi(2 nd)	
		CVR	Mean (SD)	CVR	Mean (SD)	CVR	Mean (SD)
Technological Competence	18 → 16	0.80-1.00	4.68 (0.56)	0.20-1.00	4.28 (0.78)	0.56-1.00	4.65 (0.49)
Digital Content Understanding, Search, and Evaluation	11 → 12	0.80-1.00	4.68 (0.49)	0.60-1.00	4.53 (0.64)	0.56-1.00	4.56 (0.63)
Digital Content Application and Creation	7 → 7	0.80-1.00	4.67 (0.56)	0.40-1.00	4.47 (0.67)	0.56-1.00	4.61 (0.67)
Digital Communication	11 → 13	0.80-1.00	4.81 (0.43)	0.20-1.00	4.48 (0.65)	0.33-1.00	4.54 (0.70)
CT-based Problem Solving	9 → 6	0.80-1.00	4.78 (0.44)	0.00-0.80	4.18 (0.99)	0.78-1.00	4.52 (0.72)
Social Contribution and Ethical Responsibility	13 → 10	0.80-1.00	4.81 (0.43)	0.20-1.00	4.20 (0.82)	0.56-1.00	4.60 (0.60)
Overall	69 → 64	0.80-1.00	4.73 (0.49)	0.00-1.00	4.34 (0.76)	0.33-1.00	4.58 (0.62)

4.3 Consensus and Sensitivity Analysis Across Delphi Rounds

During the Delphi process, several panelists withdrew due to time-zone differences and delayed communication. To maintain methodological rigor, replacement experts who met all predefined selection criteria were recruited. To examine whether these changes influenced the outcomes, consensus indicators (Mean, *SD*, *IQR*, Agreement Rate) and sensitivity indicators (Δ Mean, Δ *SD*) were analyzed across Rounds 1 and 2. As summarized in Table 8, consensus levels improved in the second round, and sensitivity results suggested that the framework remained stable despite partial panel turnover.

Table 8
Comparison of Consensus Across Delphi Rounds

Index	1 st Round	2 nd Round	Δ (R2–R1)	Interpretation
Mean	4.35	4.58	0.23	Increased consensus
<i>SD</i>	0.75	0.62	-0.13	Reduced variability
<i>IQR</i>	1.18	0.88	-0.30	Higher agreement
Agreement Rate (%)	88.02	93.33	5.31	Strengthened consensus
Δ Mean	-	-	0.24	Stable (Δ Mean < 0.5)
Δ <i>SD</i>	-	-	-0.13	Improved consensus

5 DISCUSSION

The DL framework developed through the South Korean and international Delphi processes achieved a relatively high level of expert consensus, suggesting that the proposed concept and six-component structure may be applicable across diverse educational and cultural contexts. The framework conceptualizes DL not merely as a set of functional skills, but as a multidimensional construct encompassing technological, cognitive, and social dimensions.

At the same time, it is noteworthy that the inclusion of CT-based problem solving within the DL framework reflects the perspective of technology education, where CT is increasingly recognized as a core approach to understanding and shaping digital systems. In this study, CT is not treated as an independent disciplinary competence but as a cognitive problem-solving strategy that supports meaningful engagement with digital technologies. From this perspective, CT complements other DL components by enabling individuals to analyze digital problems, design logical solutions, and apply technological knowledge in real-world contexts. The relatively lower agreement observed among international experts may also reflect disciplinary differences in how digital literacy is conceptualized across educational traditions.

The reorganization of DL subcomponents into basic, intermediate, and advanced levels was intended to enhance the framework's educational applicability by aligning it with learners' developmental progression. This developmental approach is consistent with discussions in technology education that emphasize conceptual understanding, design-oriented thinking, and problem-solving capabilities. In this respect, the proposed framework may be interpreted as aligning DL with core educational aims of technology education, as highlighted by de Vries (2018).

Finally, this study reflects the evolving role of technology education as it intersects with digital education, citizenship education, and ethical education. By incorporating international expert perspectives into a framework initially developed within a national context, the study offers empirical insight into how DL can be discussed beyond disciplinary and curricular boundaries. In particular, the eight subcomponents that did not meet the minimum CVR threshold are currently being refined based on qualitative analysis of expert feedback and will be re-evaluated through a third round of the international Delphi process at PATT43. Through this iterative procedure, the framework is expected to achieve greater cross-cultural validity and educational applicability. The proposed framework may therefore serve as a reference point for ongoing discussions on the role of technology education in the era of digital transformation, while remaining open to further refinement.

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