

## ORIGINAL RESEARCH ARTICLE

### A digital competence training program design based on DigComp 2.1

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This study aims to design a comprehensive and theoretically grounded digital competence training program for middle school students, based on DigComp 2.1: The European Digital Competence Framework. An explanatory sequential mixed-methods design was employed. In the first phase, the Digital Competence Identification Survey (DCIS) was administered to 262 teachers to identify the most essential competencies for seventh-grade learners. Teachers' evaluations focused on both the perceived importance of digital competencies and their suitability for the seventh-grade level. The quantitative findings were compared with the DigComp framework and the related literature, and the content development process was refined through expert review by three specialists. Rather than producing an assessment-oriented outcome, the study translated the identified competencies into a structured instructional design. The competencies selected through this process were organized into three instructional units: Information Literacy, Digital Content, and Ethics and Safety. The resulting program includes 10 themes, 22 instructional hours, and 45 learning outcomes structured according to Bloom's Taxonomy and aligned with the basic, intermediate, and advanced proficiency levels of DigComp 2.1. Data analysis combined descriptive statistics and qualitative content analysis. Instrument reliability was confirmed through high internal consistency coefficients, and content validity was ensured via expert consensus and iterative refinement. The developed program demonstrates strong alignment with national and international policy documents, including the Turkish Qualifications Framework, the Digital Turkey Action Plan, the MoNE 2023 Education Vision, and the EU Digital Education Action Plan. The study demonstrates a replicable process for translating broad digital competence frameworks into localized, actionable curricula for underserved middle school student populations.

**Keywords:** Digital competence; DigComp 2.1; instructional design; middle school students; mixed-methods design

## Introduction

Digital transformation continues to reshape social, educational, economic, and communicative spheres, making it essential for individuals to use digital technologies meaningfully, efficiently, and safely (Ferrari, 2012; Ng, 2012). However, inequalities in access to and effective use of digital tools remain significant, especially among students from disadvantaged backgrounds (Kızılkaya Namlı, 2021; Çevik & Toplu, 2023). Digital competence therefore extends beyond technical access; it includes

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conscious, critical, and creative engagement with digital environments (Geçgel et al., 2020; TVQA, 2015).

Despite the common assumption that Generation Z possesses high-level digital skills, studies show that students often lack competencies related to information use, content creation, and research (Erten, 2019; Özdemir, 2021). Their engagement with technology shapes cognitive skills such as inquiry, interpretation, and problem solving (Ala-Mutka, 2011; Ng, 2012). At the same time, issues related to online safety, privacy, ethics, and cyberbullying continue to pose challenges (Kırık & Altun, 2019; Talan & Aktürk, 2021). Digital literacy must therefore be understood as a multidimensional construct encompassing technical, ethical, cognitive, and social abilities (Ilomäki et al., 2011).

Within the context of Education 4.0, digital competence has become a core requirement for modern learning environments, emphasizing digital citizenship, critical inquiry, and creative problem solving (Öztemel, 2018; Çiftçi et al., 2021). Yet this transformation is not equally accessible to all students. Research and field observations in socioeconomically disadvantaged regions of Turkey demonstrate persistent gaps in infrastructure, internet access, and pedagogical support (Görgün Baran & Erdem, 2017; Kızılkaya Namlı, 2021). These inequalities limit not only students' access to digital tools but also their opportunities to develop foundational digital competencies required for effective participation in learning environments.

These disparities highlight the importance of needs-based instructional design in digital competence education. Aligning learning outcomes with students' current competence levels increases the relevance and effectiveness of instruction (Ekmen & Bakar, 2018). However, existing studies in Turkey and similar contexts largely focus on measuring digital competence levels or adapting international frameworks in a top-down manner, with limited attention to data-driven, needs-analysis-based curriculum design that translates competence frameworks into concrete, classroom-ready instructional programs (Ergül, 2019; Ünal & Korkmaz, 2023).

Despite the widespread recognition of digital competence as a key educational priority and the availability of comprehensive international frameworks, a critical problem remains in translating these broad competence frameworks into needs-based, developmentally appropriate, and classroom-ready instructional programs for socioeconomically disadvantaged middle school students. In particular, there is a lack of systematic and replicable curriculum design processes that integrate local educational needs with established digital competence frameworks in ways that support equitable learning opportunities.

To address this problem, it is essential to examine existing conceptualizations of digital competence and instructional design approaches in the literature, with particular attention to how international competence frameworks have been operationalized in educational contexts.

Responding to this gap, this study develops a needs-based digital competence training program informed by teacher perspectives, expert review, and a systematic alignment with the DigComp 2.1 framework (Carretero et al., 2017). Rather than merely adapting DigComp outcomes, the study demonstrates a structured process for transforming a broad competence framework into a localized, developmentally appropriate, and implementable instructional program for seventh-grade students. Learning outcomes were structured using Bloom's Taxonomy to ensure a coherent progression across cognitive levels.

The contribution of this study is threefold. Methodologically, it presents an explanatory sequential mixed-methods approach that integrates teacher-based needs analysis with expert-informed curriculum design. Practically, it offers a modular, classroom-ready digital competence program that can be implemented within existing middle school contexts. At the policy and theoretical level, it bridges high-level European digital competence frameworks with national educational priorities and classroom practice. In this regard, the study aims to support teachers and curriculum developers in designing equitable and needs-based digital competence education for middle school learners.

In order to contextualize this problem within existing research, the following section reviews key conceptualizations of digital competence, with a particular focus on international framework-based approaches to curriculum design. Special attention is given to how the DigComp framework has been interpreted, adapted, and operationalized in educational contexts, forming the theoretical foundation for the curriculum design process presented in this study.

### **Digital competence framework (DigComp)**

The rapid digitalization of social, educational, and professional domains has transformed the skills individuals must acquire to participate effectively in contemporary society. Digital competence – now recognized as a multidimensional construct – extends beyond technical proficiency and includes cognitive, ethical, and social skills that support safe, responsible, and meaningful engagement with digital environments (Erişen et al., 2018; Hazar, 2018). Within the European Commission's lifelong learning framework, digital literacy is defined as a key competency requiring individuals to access, evaluate, create, and manage information; communicate through digital tools; ensure digital safety; and solve problems in technology-mediated contexts (Ekmen & Bakar, 2018; TVQA, 2015). Developing these competencies is essential for adapting to technological change, participating in social life, and fulfilling future professional roles (Bayrakçı, 2020; Özdemir, 2021). Although digital competence frameworks provide a comprehensive conceptual foundation, translating these high-level competence descriptions into developmentally appropriate and classroom-ready instructional programs remains a key challenge in compulsory education.

To support the systematic development of these competencies, this study adopts the Digital Competence Framework for Citizens (DigComp), created by the European Commission's Joint Research Centre. First introduced in 2013 (Ferrari, 2013) and subsequently updated through DigComp 2.0 (Vuorikari et al., 2016), DigComp 2.1 (Carretero et al., 2017), and DigComp 2.2 (Vuorikari et al., 2022), the framework reflects the evolving nature of digital practices and emerging societal needs.

DigComp 2.1, which forms the conceptual basis of this research, organizes digital competence into five core dimensions:

- Information and Data Literacy, which includes searching, evaluating, and managing digital information
- Communication and Collaboration, covering online interaction, sharing, participation in digital citizenship, collaboration, digital ethics, and identity management

- Digital Content Creation, encompassing content production, editing, transformation, copyright awareness, and programming
- Safety, which includes device protection, personal data and privacy, digital well-being, and environmental sustainability
- Problem Solving, covering troubleshooting, identifying technological needs, creative digital use, and recognizing one's own competence gaps.

These dimensions collectively portray digital competence as a broad and integrated structure that goes well beyond operational skills. They highlight the need for individuals to think critically, act ethically, and participate productively in digital spaces.

In addition to defining competence areas, DigComp 2.1 proposes a structured developmental model consisting of eight proficiency levels, grouped under four overarching categories: foundation, intermediate, advanced, and highly specialized. These levels describe progression based on task complexity, degree of autonomy, and associated cognitive processes, ranging from remembering and understanding to applying, evaluating, and creating (Carretero et al., 2017). This level-based structure provides an important reference point for curriculum design; however, it does not prescribe how competencies should be sequenced, contextualized, or operationalized for specific age groups or learning contexts.

The systematic and multidimensional structure of DigComp has been widely used to guide curriculum design, policy development, and competency assessment. Particularly in basic education, it provides a comprehensive foundation for fostering digital literacy, ethical awareness, and digital citizenship (Alptekin, 2023; Kocatürk Kapucu, 2023). In the present study, teachers' views were examined in line with DigComp 2.1 to identify competence areas suitable for seventh-grade students, and these findings informed the development of a needs-based instructional program. Thus, DigComp functions not only as a theoretical model but also as a practical guide supporting application-oriented instructional design. Accordingly, DigComp is employed not merely as a descriptive framework, but as an analytical and design-oriented reference that is systematically adapted to the developmental characteristics and educational needs of middle school learners.

## **Method**

### ***Research model***

This study employed an explanatory sequential mixed-methods design, one of the established approaches within mixed-methods research. In this design, quantitative data are first collected and analyzed, and the results are subsequently elaborated and interpreted through qualitative data to provide a more comprehensive understanding of the research problem (Creswell, 2017, p. 38). This design was considered appropriate as it enabled the identification of priority digital competencies through quantitative teacher data, followed by qualitative expert-based refinement to support curriculum development.

### ***Participants***

The study sample comprised 262 teachers working in three public middle schools representing different socioeconomic contexts in the province of Adana. Of these

participants, 28.6% were employed in schools with a high socioeconomic level, 33.6% in schools with a medium socioeconomic level, and 37.8% in schools with a low socioeconomic level. Regarding teaching experience, 9.2% of the participants had 1–5 years, 27.9% had 6–10 years, 30.9% had 11–15 years, 21.8% had 16–20 years, and 10.3% had 21 years or more of professional experience.

### ***Data collection tools***

#### ***Digital Competence Assessment Survey (DC-AS)***

The survey was developed based on established Digital Competence Models and the DigComp 2.1: Digital Competence Framework for Citizens, with the aim of identifying teachers' perceptions of digital competence. Initially, the researcher designed a draft consisting of 25 items, which was subsequently reviewed by field experts for structural, content-related, and linguistic appropriateness. Based on expert feedback, two items were removed, and the remaining items were reformulated as learning outcomes. The final version of the instrument consisted of 23 items, each representing a distinct area of digital competence.

Each item was evaluated across two dimensions: (1) the perceived importance of the respective competency and (2) its appropriateness for the seventh-grade level. The survey utilized a five-point Likert scale. The response options for the 'degree of importance' dimension ranged from Not important at all to Extremely important, while those for the 'level of suitability' dimension ranged from Very low to Very high.

To examine the internal consistency of the instrument, Cronbach's alpha coefficients were calculated. The reliability coefficient for the suitability dimension (23 items) was  $\alpha = 0.93$ , while the reliability coefficient for the importance dimension (23 items) was  $\alpha = 0.97$ . The overall reliability of the combined scale (46 items) was  $\alpha = 0.97$ , indicating a very high level of internal consistency ( $\alpha > 0.90$ ).

### ***Data collection and analysis***

Teachers' responses were analyzed to rank digital competencies by perceived importance and suitability for seventh-grade students, guiding the selection of core competencies for the training program. The research followed four stages: firstly, survey data (DC-AS) were examined to identify competencies deemed both important and appropriate; secondly, these findings were compared with the literature and organized into thematic clusters based on the DigComp 2.1 framework; thirdly, content validation was conducted through a structured qualitative expert review process; and finally, the data were synthesized to determine 10 core competencies, grouped under information literacy, digital content, and ethics and security.

In the qualitative phase of the study, expert opinions were treated as qualitative data and analyzed using descriptive content analysis. This phase aimed to elaborate, refine, and contextualize the quantitative findings obtained from the DC-AS, in line with the explanatory sequential mixed-methods design. Three experts in information technologies and educational sciences reviewed the draft curriculum in terms of content relevance, developmental appropriateness, clarity of learning outcomes, and instructional time allocation. The feedback provided by the experts was systematically examined, and recurring suggestions were grouped under thematic categories such as simplification of learning outcomes, alignment with seventh-grade cognitive levels,

and coherence between themes and instructional duration. Based on this qualitative analysis, revisions were made to the structure of the units, the wording of learning outcomes, and the distribution of instructional hours. Thus, the qualitative findings functioned as a complementary explanatory component within the explanatory sequential mixed-methods design, strengthening the validity and applicability of the instructional design.

Quantitative analyses used descriptive statistics, with items prioritized based on their combined importance and relevance scores. Although no fixed numerical cut-off point was applied, competencies consistently rated high across both dimensions were prioritized, ensuring that the resulting 22-hour digital education program focused on competencies most critical for middle school students' digital development.

## **Results**

### ***Identification of priority digital competencies***

The DC-AS was administered to middle school teachers to identify digital competencies that should be prioritized in the design of the training program developed in this study. Teachers evaluated each competency in terms of both its perceived importance and its suitability for the seventh-grade level. Descriptive statistics, including arithmetic means and standard deviations, were calculated separately for all participating teachers and for Information Technology teachers, who were considered subject matter experts. The reliability of the DC-AS was found to be high. Cronbach's alpha coefficients were 0.93 for the suitability dimension, 0.97 for the importance dimension, and 0.97 for the overall instrument, indicating that the survey items were highly reliable ( $\alpha > 0.90$ ). Descriptive statistics for all DC-AS items, including mean and standard deviation values for both importance and grade-level suitability ratings, are presented in Table 1.

As presented in Table 1, teachers rated several competencies as both important and appropriate for seventh-grade students. The highest mean scores were observed for competencies related to understanding the concept of a browser, recognizing search engines, identifying filtering features, applying strong password rules, and demonstrating basic device and data protection behaviors. These findings indicate that teachers place particular emphasis on foundational information access skills and digital safety competencies.

Similarly, competencies receiving the highest suitability ratings largely overlapped with those rated highest in importance, suggesting a strong alignment between perceived necessity and developmental appropriateness at the seventh-grade level. Analysis of the responses provided by Information Technology teachers revealed slightly higher mean scores overall; however, the ranking pattern of competencies remained consistent with that of the general teacher group.

### ***Selection of core competencies for curriculum design***

In order to determine the core competencies to be included in the instructional design, competencies were evaluated based on their combined importance and grade-level suitability scores. Priority was given to competencies that consistently received higher mean scores across both dimensions.

Table 1. Mean (*M*) and standard deviation (*SD*) scores of DC-AS items by importance and grade-level suitability.

	Item no	Importance level		7th grade level suitability level		Item no	Importance level		7th grade level suitability level		
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		<i>M</i>	<i>SD</i>			
<b>All Teachers</b> ( <i>N</i> = 262)	1*	3.61	0.98	3.41	1.08	<b>IT Teachers</b> ( <i>N</i> = 32)	1*	4.00	0.98	3.90	1.11
	17*	3.50	1.10	3.11	1.22		17*	3.81	1.25	3.56	1.10
	10*	3.45	1.17	3.09	1.16		9*	3.81	1.14	3.56	1.16
	9*	3.45	1.14	3.05	1.22		16*	3.68	1.30	3.50	1.16
	16*	3.43	1.11	3.04	1.23		10*	3.65	1.38	3.43	1.26
	11*	3.27	1.15	2.86	1.08		19*	3.56	1.21	3.15	1.19
	19*	3.21	1.10	2.75	1.16		15*	3.46	1.21	3.00	0.95
	15*	3.19	1.12	2.72	1.11		3*	3.46	1.10	2.96	0.93
	3*	3.19	1.04	2.69	1.05		11*	3.43	1.34	2.87	0.97
	4*	3.07	0.99	2.44	0.88		4*	3.40	1.07	2.78	1.06

All Teachers *N*: 262; Information Technology Teachers *N*: 32.

\*: Competencies included in the scope of the research.

Note: Higher mean scores indicate higher perceived importance and suitability. Items marked with an asterisk (\*) were selected for inclusion in the instructional design based on their combined importance and suitability scores.

Rather than relying on a single cutoff score, the selection process focused on relative ranking and consistency across teacher groups. Competencies that were simultaneously rated as highly important and developmentally appropriate by both the overall teacher sample and Information Technology teachers were considered priority areas.

Based on this approach, 10 digital competencies (Items 1, 3, 4, 9, 10, 11, 15, 16, 17, and 19) emerged as the most suitable for inclusion in the training program. These competencies primarily address foundational skills related to information access, digital safety, and basic operational knowledge, which teachers perceived as critical for seventh-grade students.

The convergence of findings across importance and suitability dimensions, as well as across teacher groups, strengthened the empirical justification for selecting these competencies. Consequently, the identified competencies formed the quantitative basis for the subsequent development of instructional units, themes, and learning outcomes.

### **Identification of units, themes, and learning outcomes**

In the second phase of the study, a structural framework for digital competence training was developed based on the findings obtained from teachers' opinions.

A systematic curriculum was designed to translate the identified core digital competencies into practical educational applications. This process aimed to define the instructional units, the themes addressed within each unit, and the specific learning outcomes for each theme.

The curriculum design process consisted of four main steps:

### **1. Transforming competencies into learning outcomes:**

Drawing on the findings of the DC-AS survey and the relevant literature, 10 digital competencies identified as most important and relevant were reformulated into learning outcomes by considering not only their priority rankings but also their cognitive, behavioral, and attitudinal dimensions. This transformation process was supported by expert consultation to ensure that each outcome clearly reflected the knowledge, skills, and attitudes expected from seventh-grade students. Each outcome was articulated to clearly reflect the competencies students were expected to develop.

### **2. Identifying themes:**

The outcomes were grouped into pedagogically coherent themes in accordance with the DigComp 2.1 Digital Competence Framework and current digital competence models. Related outcomes were clustered together, and the recommended instructional duration for each theme was determined to prevent fragmentation and ensure conceptual integrity within the curriculum structure.

### **3. Sequencing and level adaptation:**

The complexity levels of the learning outcomes were simplified and sequenced appropriately for seventh-grade students. Although DigComp 2.1 defines progression through foundation, intermediate, advanced, and highly specialized proficiency levels, this study adapted the progression logic to the national educational context by organizing learning outcomes according to Bloom's Cognitive Domain Taxonomy. Accordingly, outcomes were structured to progress from lower-order cognitive processes (remembering and understanding) to higher-order processes (applying, analyzing, and creating), ensuring a gradual and developmentally appropriate learning trajectory.

### **4. Obtaining expert feedback:**

The draft curriculum was reviewed by three experts in information technologies and educational sciences. Based on their feedback, content was further simplified, certain learning outcomes were rephrased for clarity, and time allocations among themes were revised. This iterative refinement process strengthened both the content validity and developmental suitability of the curriculum. As a result of incorporating expert input, the final curriculum framework consisted of three units, 10 themes, and 45 learning outcomes, providing a coherent and developmentally appropriate structure for digital competence education.

The curriculum developed through this process comprises three main units, each designed to address distinct aspects of digital competence, as outlined below:

- **Information literacy:** This unit aims to enable students to access, filter, and select relevant information in digital environments, store it appropriately, and transform it into meaningful content. The unit includes the themes search and filter, information management, word processing, and information organization.
- **Digital content:** This unit focuses on developing students' ability to create original content using digital tools and to organize it effectively. The themes content preparation and content organization form the foundation of this unit.
- **Ethics and security:** This unit emphasizes the safe, ethical, and responsible use of information and communication technologies. Its goal is to raise students' awareness of potential digital risks and to enhance their self-protection skills. The themes include ethics and cyberbullying, password security, malware and protection, and information privacy.

These three units and their corresponding subthemes form the core structure of the digital competence training developed in this study. Each component was directly aligned with the DigComp 2.1 Digital Competence Framework and adapted to suit the developmental level of seventh-grade students. The complete program consisted of 22 h of instruction and included 45 unique learning outcomes. Furthermore, all outcomes were systematically organized according to Bloom's Cognitive Domain Taxonomy to ensure alignment between instructional objectives, targeted cognitive levels, and assessment processes. Detailed information regarding these learning outcomes is provided in the following section.

### *Creating learning outcomes based on units and themes*

Learning outcomes form the foundation of instructional programs, as they clearly and measurably define the knowledge, skills, and attitudes that students are expected to acquire through instruction. In this study, 45 learning outcomes were developed within the framework of the three units and 10 themes identified for digital competence education. These learning outcomes were not only derived from the DigComp 2.1 framework but were also systematically adapted to the national curriculum context and the cognitive developmental characteristics of seventh-grade students.

The following principles guided the development of these outcomes:

- The learning outcomes were designed to directly correspond to the competency areas outlined in the DigComp 2.1 Digital Competence Framework.
- Each outcome was simplified and adapted to align with the cognitive developmental characteristics of seventh-grade students.
- The outcomes were classified into six hierarchical levels – Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating – in accordance with Bloom's Cognitive Domain Taxonomy.
- In line with instructional practices commonly adopted in the Turkish education system, Bloom's taxonomy was used as the primary framework to ensure clarity, measurability, and alignment with assessment processes.
- A balanced distribution across these cognitive levels was ensured, with particular attention given to the inclusion of learning outcomes targeting higher-order thinking skills within each theme.

While the DigComp 2.1 framework defines three proficiency levels (foundation, intermediate, and advanced), these levels were operationalized in this study through Bloom's cognitive hierarchy to establish a clear progression from basic knowledge acquisition to higher-order cognitive processes.

Accordingly, the learning outcomes corresponding to each unit and theme, along with their classifications according to Bloom's taxonomy, are presented next.

### ***Information literacy unit outcomes***

This unit aims to actively engage students in processes such as finding, recording, organizing, and transforming information in digital environments. The structure of this unit reflects a progression from basic conceptual understanding to practical application and content creation, ensuring developmental appropriateness. Accordingly, the themes of the Information Literacy unit and the distribution of the learning outcomes for each theme according to the cognitive domain levels are presented in Table 2.

As shown in Table 2, the Information Literacy unit covers the themes of searching and filtering, information management, word processing, and information organization. Within these themes, there are a total of 17 learning outcomes: three at the Remembering level, four at the Understanding level, eight at the Applying level, one at the Analyzing level, and one at the Creating level. This distribution indicates a strong emphasis on application-oriented skills, which aligns with the practical nature of information literacy and the instructional needs of middle school students.

### ***Digital content unit outcomes***

Prior to developing the learning outcomes for the Digital Content unit – which encompasses the themes of content creation and content editing – the relevant content category was first identified, and specific learning outcomes were designed accordingly. This decision-making process was grounded in both empirical findings from the DC-AS and expert-based pedagogical considerations. During this process, expert opinions were obtained from five Information Technologies and Software teachers, each with a minimum of 5 years of professional experience. The experts were asked to evaluate potential content categories in terms of developmental appropriateness, curricular feasibility, and alignment with seventh-grade students' existing digital skill levels. Based on the experts' evaluations, the content category selected for inclusion in the instructional design was 'presentation preparation', which was subsequently approved by the thesis committee and incorporated into the study.

Within this scope, the Digital Content unit comprises a total of nine learning outcomes. The unit aims to develop students' skills in creating and editing digital presentations that demonstrate visual, textual, and structural coherence. These skills were prioritized because they represent an accessible entry point into digital content production while simultaneously supporting higher-order cognitive processes such as organization, analysis, and creativity. In formulating these learning outcomes, emphasis was placed on processes that promote the design, production, and refinement of digital products, rather than solely on technical tool use.

In alignment with the DigComp 2.1 framework, the Digital Content unit primarily addresses the 'Digital Content Creation' competence area, while Bloom's

Table 2. Distribution of learning outcomes across Bloom’s cognitive levels within the Information Literacy unit.

Theme	L. O. No	Learning outcome	R	U	A	As	E	C
<b>Search and Filtering</b>	1.1.1.	Defines the concept of a browser	X					
	1.1.2.	Explains the concept of a search engine		X				
	1.1.3.	Explains the features that can be used when filtering		X				
	1.1.4.	Performs searches using filters tailored to their needs in a digital environment			X			
<b>Information Management</b>	1.2.1.	Explains information management concepts (files, folders, drives, etc.)		X				
	1.2.2.	Defines basic file extensions	X					
	1.2.3.	Performs the process of saving files accessed in a digital environment			X			
	1.2.4.	Performs file and folder management operations			X			
	1.2.5.	Performs information management operations according to their needs using files accessed in digital environments			X			
<b>Word Processing</b>	1.3.1.	Defines the concept of word processor	X					
	1.3.2.	Gives examples of word processor software		X				
	1.3.3.	Performs the operations of the home tab of the word processor software they use			X			
	1.3.4.	Performs the insert tab operations of the word processor software they use.			X			
	1.3.5.	Performs the page layout tab operations of the word processor software they use.			X			
<b>Information Organization</b>	1.4.1.	Copies information accessed via the internet into the document they create.			X			
	1.4.2.	Organizes the information in the document they create according to their needs.				X		
	1.4.3.	Prepares a new document using information accessed via the internet.						X

R, Remembering; U, Understanding; A, Application; As, Analysis; E, Evaluation; C, Creation; L.O., Learning Outcome.

Note: Learning outcomes were intentionally concentrated at the Applying level to emphasize hands-on digital skills development appropriate for seventh-grade students.

Cognitive Domain Taxonomy was employed to structure learning outcomes according to progressive cognitive complexity. This approach ensured compatibility between the European competence-level orientation of DigComp and the instructional planning practices commonly used in the Turkish education system. Accordingly, foundational knowledge-based outcomes were positioned at the remembering and understanding levels, whereas content production and refinement tasks were associated with applying, analyzing, and creating levels. The learning outcomes corresponding to the Digital Content unit and their respective classifications within Bloom’s Cognitive Domain Taxonomy are presented in Table 3.

Table 3. Achievements and achievement levels related to digital content unit themes.

Theme	L. O. No	Learning outcome	R	U	A	As	E	C
<b>Content Creation</b>	2.1.1.	Defines the concept of a presentation	X					
	2.1.2.	Defines the concept of a slide	X					
	2.1.3.	Explains the points to consider when preparing a presentation		X				
	2.1.4.	Prepares a presentation on a specific topic			X			
<b>Content Editing</b>	2.2.1.	Adds design elements to the presentation they have prepared			X			
	2.2.2.	Adds slide transitions to the presentation they have prepared			X			
	2.2.3.	Adds animations to the presentation they have prepared			X			
	2.2.4.	Organizes the content of the presentation they have prepared according to their needs				X		
	2.2.5.	Prepares an original presentation using information accessed via the internet						X

R, Remembering; U, Understanding; A, Application; As, Analysis; E, Evaluation; C, Creation; LO, Learning Outcome.

Note: Learning outcomes were structured according to Bloom’s Cognitive Domain Taxonomy to ensure progression from foundational knowledge to higher-order digital content creation skills.

As indicated in Table 3, within the scope of the Digital Content unit, there are a total of nine learning outcomes: two at the remembering level, one at the understanding level, four at the application level, one at the analysis level, and one at the creation level. This distribution reflects a balanced emphasis on practical application while also incorporating higher-order thinking skills essential for meaningful digital content production.

### *Ethics and security unit outcomes*

The Ethics and Security unit aims to enable students to act safely, ethically, and responsibly in digital environments. This unit comprises 19 learning outcomes organized under the themes of Internet ethics and cyberbullying, password security, malicious software and protection, and information privacy. The selection of these themes was informed by teachers’ high importance ratings for digital safety-related competencies in the DC-AS, as well as increasing concerns regarding students’ exposure to online risks in everyday digital practices.

The learning outcomes were designed not only to promote the retention of foundational knowledge but also to foster students’ ability to apply, analyze, and evaluate information in authentic digital contexts. Particular emphasis was placed on real-life scenarios that seventh-grade students are likely to encounter, such as password use, online interactions, and data sharing practices. In this respect, the unit aims to

support the development of ethical awareness, risk recognition, and self-protection skills alongside technical understanding.

In alignment with the DigComp 2.1 framework, the Ethics and Security unit primarily addresses the ‘Safety’ competence area, including personal data protection, digital well-being, and responsible technology use. To ensure instructional coherence within the national educational context, Bloom’s Cognitive Domain Taxonomy was used to structure learning outcomes according to increasing cognitive complexity. This approach enabled the integration of DigComp’s competence-level orientation with Bloom’s hierarchical learning model, which is widely adopted in curriculum design in Turkey. The learning outcomes associated with the Ethics and Security unit and their corresponding classifications within Bloom’s Cognitive Domain Taxonomy are presented in Table 4.

As presented in Table 4, the Ethics and Security unit comprises a total of 19 learning outcomes: four at the remembering level, six at the understanding level, three at the applying level, four at the analyzing level, one at the evaluating level, and one at the creating level. This distribution demonstrates a deliberate balance between foundational knowledge acquisition and higher-order cognitive processes, particularly analysis and evaluation, which are essential for ethical decision-making and digital safety awareness.

### ***Overall assessment and quality of the developed teaching program***

This section examines the nature of the curriculum developed, the needs it addresses for students, its compatibility with current education policies, and its feasibility. This section provides an overall evaluation of the developed digital competence teaching program by examining its pedagogical quality, the student needs it addresses, its alignment with current education policies, and its practical applicability in school settings.

### ***Targeted needs***

The program was designed to address digital competence gaps among students from lower socioeconomic backgrounds, who often have limited access to foundational digital skills. The program was specifically designed to address digital competence gaps among students from socioeconomically disadvantaged backgrounds, who often have limited access to structured opportunities for developing foundational and applied digital skills.

Drawing on teacher input, literature findings, and the DigComp 2.1 framework, the program focuses on developing students’ ability to:

- Access, evaluate, and manage digital information
- Create and edit digital content
- Practice ethical digital behavior and cybersecurity
- Solve everyday digital challenges.

Overall, the program takes a holistic approach, fostering not only technical skills but also digital awareness, critical thinking, and responsible digital citizenship. By addressing these dimensions collectively, the program adopts a holistic approach to digital competence development. Rather than focusing solely on technical skills, it

Table 4. Achievements and achievement levels related to ethics and security unit themes.

Theme	L. O. No	Learning outcome	R	U	A	As	E	C
<b>Internet Ethics and Cyberbullying</b>	3.1.1.	Defines the concept of internet ethics	X					
	3.1.2.	Explains the importance of adhering to internet ethics		X				
	3.1.3.	Defines the concept of cyberbullying	X					
	3.1.4.	Deals with cyberbullying behaviors that may be encountered in digital environments			X			
	3.1.5.	Analyzes behaviors involving ethical violations and cyberbullying					X	
<b>Password Security</b>	3.2.1.	Explains the rules to follow when creating strong passwords		X				
	3.2.2.	Lists the measures required to ensure password security		X				
	3.2.3.	Creates strong passwords to protect devices and information in digital environments						X
	3.2.4.	Performs the process of defining the strong password they have created for the device they use			X			
	3.2.5.	Evaluates the security levels of passwords according to strong password creation criteria					X	
<b>Malicious Software and Protection</b>	3.3.1.	Defines the concept of malware	X					
	3.3.2.	Explains the types of malware		X				
	3.3.3.	Distinguishes the type of malware based on the problem occurring on the computer				X		
	3.3.4.	Defines the concept of security software	X					
	3.3.5.	Explains the types of security software		X				
	3.3.6.	Performs malware scans on the device they use to protect their information in the digital environment.			X			
<b>Information Privacy</b>	3.4.1.	Explains the precautions that can be taken during the information sharing process		X				
	3.4.2.	Analyzes the privacy and security measures required to protect their information in the digital environment				X		
	3.4.3.	Distinguishes the digital content they can share in order to protect their privacy in digital environments				X		

R, Remembering; U, Understanding; A, Application; As, Analysis; E, Evaluation; C, Creation; LO, Learning Outcome.

Note: Learning outcomes were structured to reflect progressive cognitive complexity, with emphasis on ethical reasoning and safe digital practices in line with the DigComp 2.1 Safety competence area.

emphasizes digital awareness, critical thinking, ethical responsibility, and safe technology use. This comprehensive structure is particularly important for students with limited prior exposure to systematic digital skills education, as it supports both functional competence and responsible digital citizenship.

### ***Alignment with education policies***

The developed digital competence training program is directly aligned with high-level policy documents such as the Turkish Qualifications Framework (TQF), the Digital Turkey Goals, the Ministry of National Education's 2023 Education Vision, and the European Union's Digital Education Action Plan.

- The competencies outlined in the TQF – such as acquiring essential life skills and using technology safely and effectively – correspond directly to the objectives of this program (TVQA, 2015).
- The program's content is closely related to the targets of '*digital education at every stage of life*', '*digitization of educational content*', and '*promotion of digital literacy*' identified under the '*10 Steps for the Future*' in the Digital Turkey Roadmap (Ministry of Science, Industry, and Technology, 2018).
- In accordance with the goals of '*equipping individuals with 21st-century skills*' and '*developing an ecosystem for digital content and skills*' set out in the Ministry of National Education's 2023 Education Vision, the program provides a concrete and practical response for middle school students.
- The program's foundation in the DigComp 2.1 Digital Competence Framework ensures its validity and comparability both at the national and international levels (Carretero et al., 2017).

Furthermore, grounding the program in the DigComp 2.1 Digital Competence Framework enhances its conceptual validity and enables comparability with international digital competence initiatives. Overall, the program not only addresses individual learning needs but also contributes to broader national and international goals related to digital transformation and educational reform, effectively bridging the gap between policy objectives and classroom-level implementation.

### ***Applicability***

The program is designed for easy integration into the middle school curriculum. Key features include:

- A 22-h duration suitable for elective courses or extracurricular activities
- Learning outcomes structured according to Bloom's Taxonomy, mainly at the Remembering, Understanding, and Applying levels
- Simple, practical themes requiring only basic computers, internet access, and presentation software
- Modular content that can be delivered independently, allowing flexibility for time and technical constraints
- Support for schools with limited infrastructure through teacher guidance and visual aids.

The program was designed with practical constraints and school realities in mind, ensuring its feasibility in diverse educational contexts. Learning outcomes are structured according to Bloom's Cognitive Domain Taxonomy, with a primary emphasis on the remembering, understanding, and applying levels, which are appropriate for students who are developing foundational digital skills. In addition, the modular structure of the content allows each unit to be implemented independently, providing flexibility for schools facing time limitations or technical constraints. Teacher guidance, visual materials, and step-by-step activities further support implementation in schools with limited resources.

Overall, the program is developmentally appropriate, time-efficient, flexible, and provides clear guidance for teachers, enhancing both its practical applicability and potential for broad implementation. Taken together, these features indicate that the program is developmentally appropriate, time-efficient, and adaptable, enhancing both its practical applicability and its potential for sustainable and widespread implementation.

### **Conclusion and discussion**

This study developed a digital literacy education program for seventh-grade middle school students, aiming to equip them with fundamental digital skills such as accessing information, creating digital content, and acting ethically in digital environments, in response to the identified need for a data-driven, needs-based curriculum design that translates abstract digital competence frameworks into classroom-level instructional practice. The program was structured based on the DigComp 2.1 Digital Competence Framework and organized into three main units – Information Literacy, Digital Content, and Ethics and Security – comprising 10 themes and 45 learning outcomes. Accordingly, the study presents a systematic instructional design model grounded in theoretical perspectives on digital competence education. Beyond technical proficiency, the program seeks to cultivate conscious, productive, and responsible digital citizens who can critically engage with digital technologies. The competencies addressed in the program align with the broader goal of developing individuals capable of effectively using, evaluating, and producing digital content while maintaining personal and data security. Thus, the study provides a concrete educational adaptation of the DigComp framework proposed by the European Commission (Carretero et al., 2017; Vuorikari et al., 2022).

The existing literature emphasizes that digital competence is a multidimensional construct encompassing interrelated components such as information literacy, content creation, communication, security, and problem-solving (Calvani et al., 2008; Ferrari, 2013). Consistent with this perspective, the program developed in this study adopts a holistic pedagogical approach, systematically integrating cognitive progression through Bloom's Taxonomy with the competency areas defined in the DigComp 2.1 framework, and adapted to the developmental characteristics of seventh-grade students. This design ensures that learning extends beyond the acquisition of factual knowledge to the application, transformation, and evaluation of that knowledge in meaningful contexts.

Furthermore, the detailed distribution of each digital theme by weekly instructional hours supports a systematic and cumulative progression in the learning process. Rather than treating digital competence as a set of isolated skills, the program was designed to ensure continuity and scaffolding across units and themes. The program's structure was designed in line with the implementation principles of both the TQF

and European educational models (Carretero et al., 2017; TVQA, 2015). By integrating the DigComp framework, the program aims not only to develop technical skills but also to foster ethical awareness and digital responsibility. Specifically, through topics such as cyberbullying, privacy, password security, and protection against malware, included under the Ethics and Security unit, students are guided to recognize potential digital risks and take preventive measures.

The rapid integration of artificial intelligence (AI) tools into educational environments has expanded contemporary discussions on digital competence. Although this study is grounded in the DigComp 2.1 framework, the competencies addressed in the developed program – particularly information literacy, digital content creation, ethical awareness, and data security – represent foundational skills that support the development of AI literacy. Critical evaluation of digital information, responsible content production, and ethical digital behavior are increasingly recognized as prerequisites for the effective and safe use of AI-supported technologies in education. Recent research also emphasizes that while generative AI tools can produce clear and coherent outputs, their effective use in educational and academic contexts depends heavily on users' abilities to critically evaluate accuracy, bias, and ethical implications rather than relying on AI-generated content uncritically (Tülübaş et al., 2023). From this perspective, the proposed program not only addresses current digital competence needs but also prepares students for future learning contexts in which AI-based tools are expected to become more prevalent (Ng et al., 2021; UNESCO, 2023).

The competencies targeted by the program align not only with pedagogical objectives but also with national and international policy frameworks. Designed to equip students with the digital skills outlined in the TQF and the MoNE 2023 Education Vision, the program is consistent with key priorities of the European Union's Digital Education Action Plan, including digital citizenship, cybersecurity, problem solving, and content creation (Carretero et al., 2017; MoSIT, 2018; TVQA, 2015). In this respect, the proposed instructional model contributes to bridging the gap between policy-level digital competence goals and classroom-level instructional practices.

Within this context, the explanatory sequential mixed-methods design adopted in the study constitutes a key methodological strength of the proposed instructional model. Quantitative findings derived from teachers' evaluations provided an empirical basis for identifying priority digital competencies, while the subsequent qualitative expert review enabled the interpretation, refinement, and contextualization of these findings. Rather than functioning as an auxiliary stage, the qualitative phase operated as an explanatory mechanism that informed revisions to learning outcomes, unit structure, and instructional duration. This integration ensured methodological coherence between needs analysis, curriculum design, and pedagogical decisions, thereby strengthening the validity and practical relevance of the developed program.

In line with the problem formulated in the introduction, a review of the literature reveals that while numerous studies address the development of students' digital competencies (Ergül, 2019; Hatlevik et al., 2015; Mifsud, 2020), few have systematically structured these competencies across acquisition, theme, and unit levels or aligned them with taxonomic learning stages. Unlike existing studies that predominantly focus on assessment or general framework alignment, the present research offers a comprehensive instructional design model that operationalizes digital competence through clearly defined units, themes, and learning outcomes. In this respect, the present research contributes a model program that is theoretically valid, pedagogically sound, and methodologically transparent at every stage of instructional design.

This methodological approach provides a foundation for developing context-sensitive teaching content that considers the specific needs of students affected by digital inequality. It emphasizes the use of multiple data sources and the developmental characteristics of the target group, thereby moving digital literacy education beyond generic framework alignment toward a data-driven, user-centered, and contextually relevant structure. The resulting curriculum not only reflects teachers' practical insights but also aligns with the digital competence objectives embedded in national curricula.

In conclusion, although this study does not include an implementation phase, the developed program constitutes a unique instructional model illustrating how digital competencies can be designed based on pedagogical, theoretical, and policy foundations. It fills a significant gap in the field of digital competence education for middle school students and provides a replicable structure for future curriculum development. When scaled at the national level, such structured educational practices can play a pivotal role in enabling students to become active, critical, and responsible participants in the digital society. Moreover, the model offers a practical and adaptable framework particularly suited to socioeconomically disadvantaged regions, where reducing the digital divide remains a pressing educational priority.

Finally, addressing the problem of translating broad digital competence frameworks into context-sensitive and implementable curricula, although this study focused on the design of a digital competence education program rather than its classroom implementation, the issue of assessing learning outcomes remains an important consideration for future applications. Given the performance-oriented nature of digital competencies, future implementations of the program could employ alternative assessment approaches such as student digital portfolios, performance-based tasks, structured observation forms, and analytic rubrics aligned with the learning outcomes. Such formative and process-oriented assessment tools may enable educators to monitor students' progression across the 45 learning outcomes and to capture dimensions of digital competence that are not adequately reflected through traditional testing methods. Addressing assessment strategies in this way may contribute to evaluating the instructional effectiveness of the program in real classroom contexts.

### **Limitations and future research**

Several limitations of this study should be acknowledged. Firstly, the identification and prioritization of digital competencies were based on teachers' perceptions of importance and suitability for seventh-grade students. Although teachers provide valuable pedagogical insights, reliance on teacher-reported data may not fully capture students' actual digital competence levels and may reflect assumptions associated with the 'digital native' perspective. Future research could address this limitation by incorporating student self-assessment instruments, diagnostic performance-based tasks, or mixed assessment models that combine teacher, student, and observational data.

In addition, this study was limited to the design phase of the instructional program and did not include an empirical implementation or effectiveness evaluation. Future studies may focus on piloting the program in diverse school contexts, examining learning outcomes through systematic assessment strategies, and exploring its adaptability to different grade levels or educational systems. Such research would provide empirical evidence regarding the instructional impact of the proposed model and further inform digital competence curriculum development.

### **Author contribution**

This study was produced from a doctoral dissertation titled “*An action research study aimed at developing the digital competency levels of middle school students,*” conducted by Emre Canoğulları under the supervision of Prof. Dr. Mediha Sarı at Çukurova University.

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### **Conflict of interest**

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

### **Availability of data and material**

Data are available from the corresponding author upon reasonable request.

### **Ethical approval**

The study protocol was reviewed and approved by the Ethics Committee of Çukurova University, Social and Human Sciences Board (approval number: 04/11/2021-E.234576). The research was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

### **Consent to participate**

Informed consent was obtained from all participants involved in the study.

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