International Journal of Assessment Tools in Education
2026, Vol. 13, No. 1, 270–288
https://doi.org/10.21449/ijate.1659953
journal homepage: https://dergipark.org.tr/en/pub/ijate
Research Article

Turkish adaptation of Digital Fluency Scale for high school students

Ecem Tunca[1*], **Aynur Kolburan Geçer**[2]

[1]Information Technologies Teacher, İstanbul, Türkiye
[2]Kocaeli University, Faculty of Education, Department of Computer Education and Instructional Technology, Kocaeli, Türkiye

ARTICLE HISTORY

Received: Mar. 17, 2025

Accepted: Nov. 16, 2025

KEYWORDS

Confirmatory factor analysis,
Digital fluency,
Reliability,
Scale adaptation,
Validity.

Abstract: The aim of this study was to examine the validity and reliability of the Turkish adaptation of the Digital Fluency Scale developed by Chou and Chiu (2020). The structural and linguistic validity, and the equivalence of the scale with the Turkish version was confirmed. For the pilot study, the scale was administered to 60 high school students using a test-retest method at a two-month interval, and correlations were examined. Validity and reliability analyses were conducted with a sample of 420 high school students in Eskişehir. Confirmatory Factor Analysis (CFA) was used to assess the construct validity of the scale, and the following fit indices were obtained: χ^2 / *df* = 3.862; RMSEA = .079; SRMR = .056; GFI = .907; NFI = .856; TLI = .866; and CFI = .888. The first-level CFA results confirmed that the sample size was sufficient for factor analysis. Additionally, a second-order CFA supported the conceptualization of digital fluency as a higher-order latent construct encompassing four core factors. The scale demonstrated high internal consistency, with a Cronbach's alpha of 0.89. Significant correlations were observed among the subscales and between each subscale and the total scale score. These findings demonstrate that the Turkish version of the Digital Fluency Scale is a valid and reliable tool for assessing digital fluency in high school students.

INTRODUCTION

In today's world, the development of digital technologies and their deep penetration into daily life have made it even more necessary for individuals to acquire digital skills. This technological transformation has had a significant impact on various aspects of society. In particular, areas such as business, education, communication, and social life have been profoundly influenced. In this context, it has become increasingly important for individuals to develop their digital skills. Today, using these skills effectively in line with one’s goals is no longer a mere necessity but an essential requirement. Digital skills can be defined as the ability of individuals to use technology effectively and access reliable information in digital environments (Blayone, 2019). These competencies include various areas such as information search, digital communication, data management, problem solving and programming. Having digital skills provides a significant advantage in terms of success and career development in the business world today (Coward, 2018; Pichler & Stehrer, 2021).

*Corresponding author at: Ecem TUNCA ecemtunca97@gmail.com Information Technologies Teacher, Istanbul, Türkiye

e-ISSN: 2148-7456

In the literature, the importance of individuals having cognitive skills related to digital competencies in solving the problems they face in the digital age is emphasized (Sönmez & Gül, 2014). Digital literacy has become a critical competency in the information age (Ince, 2022). This concept refers to individuals' competencies in accessing, understanding, evaluating, and effectively using information in digital environments (Demir, 2018). It has also been stated that it consists of a series of skills and competencies that require interaction with digital tools and platforms (computers, smartphones, tablets, the internet, etc.) (JISC, 2014). These skills facilitate the individual's access to information and develop critical thinking and communication skills (Murtadho *et al.*, 2023). Today, the concept of digital literacy has fallen behind the pace of technological advancements. As a result, it has been replaced by a more advanced competency known as digital fluency (National Research Council, 1999). Digital fluency has been defined as the ability of individuals to communicate effectively, interact, and share information in creative ways on digital platforms (Liu *et al.*, 2018). Wang *et al.* (2013) conceptualize digital fluency as the capacity to reconstruct and generate information in digital environments. This process must be carried out in ways that are both contextually appropriate and creatively effective.

Miller and Barlet (2012) suggested that individuals who are digitally literate can achieve digital fluency if they possess critical thinking skills. On the other hand, Liu *et al.* (2018) defined digital fluency as the ability to acquire new information obtained through the use of technology and to adapt to digital world transformations. The concept of digital fluency has been examined from various perspectives by many scientists from different fields. Briggs and Makice (2012) explained digital fluency in four categories: Anti-Digital Literacy, Pre-Digital Literacy, Digital Literate, and Digital Fluent (Figure 1).

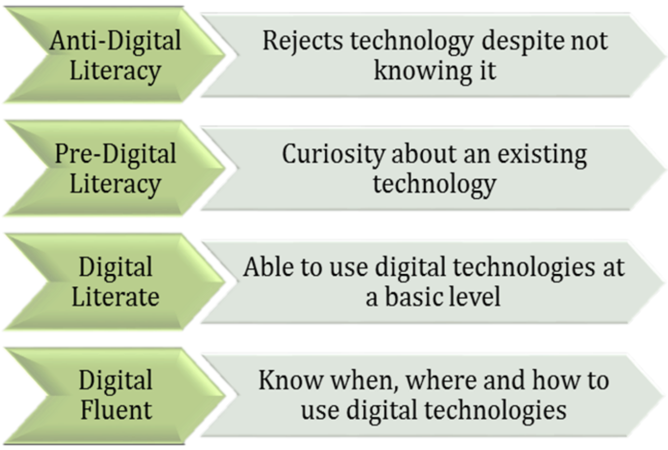

Figure 1. *Phases of digital fluency (Briggs & Makice, 2012).*

In today's world, there is a growing need for individuals with digital fluency. Several factors contribute to this demand. First, although young people often perceive themselves as highly digitally competent, their actual skills frequently fall short. Second, individuals with limited digital abilities struggle to effectively solve problems that arise in collaborative work. Third, modern educational approaches, such as STEM and Maker programs, require advanced digital skills. Fourth, it is essential for individuals not only to consume digital content but also to generate data-driven information. Finally, lifelong learning, development, and skill maintenance necessitate continuous digital proficiency (Resnick, 2012).

The education system aims to support students in progressing from basic literacy skills to digital literacy, and ultimately, digital fluency (Briggs & Makice, 2012). In this context, determining students' current digital fluency levels is crucial for evaluating their competence and effective use of digital environments. Digital fluency skills equip students with essential competencies, including critical thinking, problem solving, creativity, as well as awareness of digital ethics and privacy (Alexander *et al.*, 2019; Miller & Bartlet, 2012; Wang *et al.*, 2013). With the increasing use of digital technologies in learning environments, students have greater access to digital resources (Gil-Flores *et al.*, 2012). In an increasingly digital world, assessing students' digital skills is crucial for education systems to adapt to this transformation (Aksoy *et al.*, 2021; Hague & Payton, 2011; Hamutoğlu *et al.*, 2017; Kozan & Özek, 2019; Reddy *et al.*, 2020). High school education constitutes a critical phase that prepares young individuals for both their academic and professional careers. In this process, education systems aim not only to facilitate the use of digital tools but also to develop students' competence in managing these tools effectively (Calvani *et al.*, 2008). However, traditional measurement methods fall short in fully capturing the multifaceted nature of digital skills. A comprehensive understanding of students' digital literacy requires an approach that addresses not only technical skills but also the associated cognitive and social dimensions (Ribble, 2011). In the literature, it is seen that students have difficulties in using, interpreting and organizing digital materials (Lorenzo & Dziuban, 2006; Mudra, 2020). Digital fluency scales stand out as an ideal tool for this comprehensive assessment. Digital fluency refers to the capacity of individuals to use digital environments effectively and integrate technology into creative and critical thinking processes (Spante et al., 2018). In this direction, digital fluency scales not only measure students' level of technology use; they also evaluate broader competencies such as digital security, ethical digital behavior and access to digital information (Hatlevik *et al*., 2015). Such a measurement enables students to identify the areas in which their digital competencies are insufficient. It also allows educators to design targeted interventions to address these gaps. Furthermore, the results can inform policymakers to improve educational strategies accordingly (Eynon & Geniets, 2016).

As a result, effectively developing and monitoring digital fluency in high school students is an important need for the future workforce. Considering the rapid growth of technology-based professions today, individuals with technological competencies are expected to have advantages in their careers. Therefore, possessing strong digital skills is increasingly important for professional success (Şahin, 2023). Digital fluency has become a necessity rather than a choice today (Howland & Scott, 2016). In this context, digital fluency scales provide students with the opportunity to become aware of their own digital competencies and offer schools the opportunity to make digital literacy programs more effective. In order for students to be successful in the digital world, such scales should be at the center of strategic planning and evaluation processes. In an era of accelerating technological advancements, there is a clear need for a measurement tool to assess students' digital fluency skills. To address this need, this study aims to adapt the Digital Fluency Scale, developed by Chou and Chiu (2020), for Turkish culture. This adaptation is a crucial step for evaluating digital fluency skills and is expected to contribute to addressing existing gaps in the field. The adapted Digital Fluency Scale will serve as a vital tool for assessing high school students' digital fluency. The scale also has the potential to provide a foundation for developing programs and activities designed to enhance these skills, thereby enabling a more effective integration of digital competencies into educational processes.

The theoretical framework of this study is grounded in the developmental and cross-cultural universality of digital fluency. Prior research emphasizes that digital fluency evolves progressively from middle school through adolescence and integrates cognitive, social, and ethical dimensions of digital competence (Liu *et al*., 2018; Wang *et al*., 2013). This study therefore focuses on high school students, who possess more advanced cognitive and metacognitive capacities to understand and apply digital citizenship, critical thinking, and innovation-related behaviors. In the Turkish curriculum, these competencies are explicitly taught under the "Ethics, Security, and Society" unit of the *Computer Science* course, providing both a developmental and contextual rationale for adapting the scale at the high school level. Accordingly, the adaptation of the Digital Fluency Scale to this population is theoretically justified and developmentally appropriate.

The aim of this research is to adapt the Digital Fluency scale developed by Chou and Chiu (2020) to Turkish culture. This adaptation study can contribute to both national and international literature by providing a reliable and valid tool for assessing high school students' digital fluency skills.

Research Related to Digital Fluency

The concept of digital fluency refers not only to individuals' ability to use digital technologies, but also to their ability to use these technologies in a meaningful, critical, and productive manner (Eshet-Alkalai, 2004). In this context, digital fluency stands out as an important competency in terms of individuals' adaptation to the requirements of the digital age. Various scale development studies aimed at measuring digital fluency can be found in the literature. For example, the Digital Fluency Scale developed by Demir (2018) for teacher candidates consists of three factors—awareness, self-efficacy, and affective—and 29 items. Altunkaynak and Çağımlar (2023) developed a five-subscale scale to determine teachers' digital fluency levels. Kim *et al.* (2013) developed a 36-item scale to measure teachers' digital fluency, which includes problem identification, information acquisition, analysis, and communication skills. Chou and Chiu (2020) developed a 15-item scale with four dimensions—digital citizenship, innovation, critical thinking, and research—to determine the digital fluency of elementary school students.

A common feature of these studies is that they address digital fluency measurement in relation to different age groups and occupational groups. However, a review of the literature reveals that studies on the development or adaptation of digital fluency scales for high school students are quite limited. This situation makes it difficult to systematically and validly measure the digital fluency levels of high school students, who interact intensively with digital technologies from an early age. Therefore, there is a need for measurement tools that are appropriate for the developmental characteristics of high school students and take cultural context into account.

At this point, adapting existing scales that are appropriate to the cultural context is considered a more effective and methodologically sound approach than developing a new scale. The use of adapted scales naturally saves time, increases the generalizability of the data obtained, and allows for the examination of similarities and differences between different societies (Borsa *et al.*, 2012; Nilsson *et al.*, 2016). Furthermore, the cultural adaptation process is not merely a translation; it is a multi-stage process that includes elements such as conceptual equivalence, contextual appropriateness, and comprehensibility according to the target age group (Hambleton, 2001). The "digital fluency" latent variable measured in this study has a meaningful counterpart in both the Taiwanese (Chou & Chiu, 2020) and Turkish samples. Digital fluency is not merely a technical proficiency; it is a set of cognitive and social skills with universal dimensions such as creative thinking, critical evaluation, digital citizenship, and collaboration. In the literature, digital fluency is defined as a structure with cross-cultural validity (ISTE, 2018; Wang *et al.*, 2013). The concept of digital fluency encompasses common behavioral patterns in areas such as interaction with technology, information production, digital content creation, and social participation, making it reasonable to compare it between two cultures. In increasingly digitized education systems, it has become a universal requirement for students to possess these skills. Digital fluency serves as an indicator guiding both educational policies and digital pedagogy, as it reflects students' cognitive and creative competencies in the context of interacting with technology. In this context, examining how digital fluency is shaped across different educational systems enables comparative analyses in terms of instructional materials and teacher training.

In this context, adapting existing scales that are appropriate for high school students in terms of content and structure to the Turkish cultural context offers a more advantageous way to measure digital fluency in a valid and reliable manner. The scale adaptation process followed the scale adaptation steps proposed by Hambleton and Patsula (1999).

METHOD

In this study, the technical features (evidence of validity and reliability) of the "Digital Fluency Scale" developed by Chou and Chiu (2020) were examined and its adaptation to Turkish culture was made. The adapted scale is included in Appendix 1.

Study Participants

The validity and reliability studies of the Digital Fluency Scale were conducted with a total of 420 students studying in high schools in Eskişehir. Büyüköztürk (2012) stated that when conducting CFA (Confirmatory Factor Analysis) for adaptation studies, it should be conducted with at least 300 participants for the validity of the adapted scale. Data were collected from 432 students in the data collection process of the study, but 12 of the total data were deleted due to extreme values. The distribution of demographic characteristics of the participants is given in Table 1.

Table 1. *Demographic Information of Participants.*

Gender	*n*	*f* (%)
Woman	279	66.4
Male	141	33.6
Grade		
1st grade	219	52.1
2nd grade	55	13.1
3rd grade	59	14.0
4th grade	87	20.7
Age		
15-16	297	70.7
17-18	123	29.3
Foreign language level		
Beginner	71	16.9
Intermediate	288	68.6
Advanced	61	14.5
Internet usage competence		
Low	5	1.2
Middle	191	45.5
High	224	53.3
Frequency of Internet use (per day)		
1-2 hours	63	15.0
3-6 hours	242	57.6
More than 6 hours	115	27.4

Data Collection Tool

The original scale was developed by Chou and Chiu (2020). The scale consists of four dimensions: Collaboration and Research, Digital Citizenship, Critical Thinking, and Innovation Design. The scale is a 15-item, 7-point Likert-type scale and does not include reverse-scored items. The original scale was administered to middle school students in Taiwan. The sub-dimensions of the Digital Fluency Scale and the high scores obtained from the general scale indicate that individuals have a high level of digital fluency. Exploratory and confirmatory factor analyses of the scale were conducted by Chou and Chiu (2020). An exploratory factor analysis was performed on the scale. The KMO value was found to be .913. The Bartlett sphericity test was significant, χ^2 (253) = 3789.26, p < .001. The results of the factor analysis's principal components with direct Oblimin rotation indicated that the cumulative percentage of variance explained was 71.73%. The Cronbach's alpha value for all items was .95. The confirmatory factor analysis results indicate that the revised four-factor model for Digital Fluency fits the data moderately well, with degrees of freedom = 86, GFI = .929, AGFI = .901, CFI = .958, and NNFI = .949, RMSEA = .068, 95% CI [.057, .079]. It is stated that all factor loadings of the items are meaningful and that factor loadings range from .59 to .90. To evaluate the validity and reliability of the Digital Fluency Scale, researchers examined CR and AVE. CR ranged from .828 to .917, exceeding .7, and Cronbach's alpha value was .946, exceeding .7. The composite reliability values for the four dimensions of the scale were found to be acceptable. Ethics committee approval for this study was received from Kocaeli University Social and Human Sciences Field Scientific Research and Publication Ethics Committee on 28.12.2022, with decision number 13. Before the research started, the participants were informed in detail about the process and were asked to fill out informed consent forms.

Ethical approval (10.01.2023; letter no. 346471) was obtained from Eskişehir National Education Directorate for the high schools where the data would be collected. After obtaining permission, printed scales were used to reach the students. Students were informed about the research before starting the application. Data were collected from those who volunteered to participate. In addition, information about the research and voluntary consent section were added to the beginning of the applied scale. Participants were informed about the purpose of the research to ensure confidentiality, respect for privacy and ethical issues.

Process of Translating the Scale into Turkish

Initially, necessary permissions were obtained from the developers of the Digital Fluency Scale (DFS) for Preadolescent Children, Chou and Chiu (2020), via e-mail on November 14, 2022. Following this approval, the scale was translated from English to Turkish. A crucial step in adapting measurement tools for another culture is ensuring accurate translation without loss of meaning (Geisinger, 1994). During the translation, linguistic equivalence was ensured using a bilingual design method involving eight experts, four English and four Turkish specialists. The data collected to evaluate construct validity were analyzed after applying appropriate preprocessing techniques. The path followed in the adaptation of the scale is shown in Figure 2.

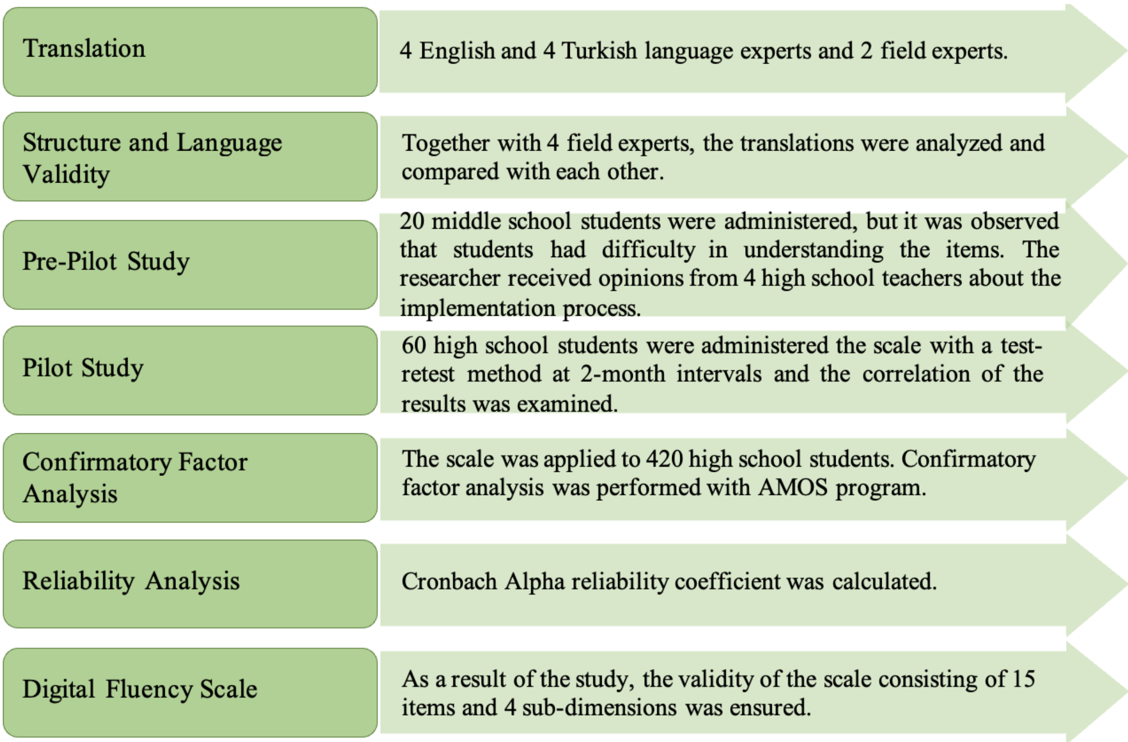

Figure 2. *Scale adaptation.*

Scale Application Process

The adapted scale was initially administered to 20 volunteer middle school students (Tunca, 2024). However, the collected data revealed that many students struggled to understand the questions, leaving several unanswered items. In post-administration interviews with the students, they stated that they had not studied some items in middle school and could not relate them to themselves (e.g., IA4. I can use digital tools to process, analyze, and report experimental and research results; IA3. I can use digital tools to help me plan strategies for conducting experiments or research), and therefore did not answer them.

Three IT teachers at the school where the implementation took place, the researcher behind this thesis (an IT teacher), and an academic working in the field of Instructional Technologies reviewed the scale items to be adapted and the middle and high school IT programs. They observed that the elective topic of "digital citizenship" at the middle school level was narrowly covered in the "Information Technologies and Software" course in 5th and 6th grades, while at the high school level, these topics were covered more broadly under the headings "digital fluency" and "digital citizenship" within the "Ethics, Security, and Society" unit of the "Computer Science" course.

Furthermore, digital fluency/digital citizenship is not conceptually a skill set specific to elementary school; the sub-dimensions measured by the scale developed by Chou and Chiu (2020) -digital citizenship, critical thinking, collaboration/research, and innovative design-are evolving and educationally important competencies that are also relevant in adolescence. Therefore, the theoretical content of the scale is directly relevant for high school students.

Accordingly, they concluded that, given high school students' digital fluency and digital citizenship levels, implementing the scale at the high school level would be more appropriate. Consequently, the adaptation studies were conducted with high school students. For the validity and reliability analysis of the revised scale, 60 volunteer high school students from Eskişehir—each with an English course score of 70 or above in the previous year—were selected, and the original version of the scale was administered. During the adaptation process, four English teachers from Eskişehir high schools translated the scale items into Turkish. Subsequently, the translations were refined for semantic integrity with the support of four academics specializing in Computer and Educational Technologies Education, English, and Measurement and Evaluation.

To conduct the pilot application, the adapted scale was administered again to the same 60 volunteer high school students after two months. Test-retest reliability was assessed by calculating the correlations between the two administrations, which showed strong consistency. Based on these results, the Turkish adaptation of the scale was considered ready for use.

Evidence of Linguistic, Conceptual, and Structural Equivalence

To ensure the linguistic and cultural equivalence of the Digital Fluency Scale, the adaptation process followed internationally recognized guidelines (Hambleton, 2001; Hambleton & Patsula, 1999; ITC, 2017). The process was designed to establish semantic, idiomatic, experiential, conceptual, and structural equivalence between the original Taiwanese and Turkish versions.

Semantic equivalence: The translation and back-translation procedures were carried out by eight bilingual experts (four English, four Turkish) and two field specialists. Consensus was achieved through iterative revisions to guarantee that the Turkish items retained the same linguistic meaning and conceptual content as the original items (Geisinger, 1994).

Idiomatic equivalence: Expressions or terms that lacked direct Turkish equivalents were adapted to convey the intended meaning appropriately (e.g., “experimental and research results” was rephrased to reflect students’ real learning contexts).

Experiential equivalence: A pre-pilot study with 20 middle school students and a pilot with 60 high school students ensured that the items corresponded to students' real experiences with technology. Feedback revealed that middle school students had difficulty comprehending certain items involving digital data analysis or research; thus, the high school group was selected for the final adaptation due to their more advanced digital experience and cognitive readiness.

Conceptual equivalence: Two academics specializing in Educational Technology reviewed all items to confirm that the core constructs of digital citizenship, collaboration and research, critical thinking, and innovation design are conceptually valid and culturally meaningful within the Turkish education system (Borsa *et al*., 2012).

Structural equivalence: First- and second-order Confirmatory Factor Analyses (CFA) replicated the original four-factor structure of the scale, providing strong evidence that the underlying latent construct—digital fluency—is represented consistently across both cultural contexts.

These combined procedures demonstrate that the Turkish version of the Digital Fluency Scale preserves both linguistic accuracy and conceptual integrity, fulfilling international standards for cross-cultural test adaptation.

Data Analysis

Before conducting Confirmatory Factor Analysis (CFA), the dataset was examined to ensure compliance with CFA assumptions, including multivariate normality, outliers, and missing data. Multivariate normality was assessed using Mardia's coefficient, which yielded a value of 5.74, indicating mild non-normality. Consequently, CFA was performed using the Maximum Likelihood Estimation with Robust Standard Errors (MLR) in AMOS 24, which provides reliable parameter estimates under moderate deviations from normality.

Outliers were identified using Mahalanobis distance ($p < .001$), resulting in the removal of 12 cases. No missing data were detected, as all scales were administered in person under the supervision of the researcher.

Model fit was evaluated using standard fit indices: χ^2 / df, CFI, TLI, RMSEA, SRMR, GFI, and AGFI. The following criteria guided the interpretation of model fit:

CFI ≥ .90 indicates acceptable fit; ≥ .95 indicates good fit (Hu & Bentler, 1999).

TLI ≥ .90 indicates acceptable fit (Marsh *et al*., 2006).

RMSEA ≤ .08 indicates acceptable fit; ≤ .05 indicates good fit (Byrne, 1998).

SRMR ≤ .08 indicates acceptable fit (Schermelleh-Engel & Moosbrugger, 2003).

Factor loadings of ≥ .40 were considered acceptable (Hair *et al*., 2010). Internal consistency reliability was assessed using both Cronbach's alpha (α) and McDonald's omega (ω) coefficients for each subscale and the overall scale. Reporting both statistics offers a more comprehensive estimation of reliability (Dunn *et al*., 2014). All statistical analyses were conducted using SPSS 25 and AMOS 24 software.

To evaluate the construct validity of the adapted scale, CFA was employed to test the alignment of the sample data with the original four-factor structure. In scale adaptation studies, the choice between exploratory and confirmatory factor analysis is a critical methodological decision. Given that the original factor structure had already been established, CFA was deemed appropriate for this study. The literature supports the use of CFA in adaptation processes, particularly when the theoretical structure is predefined (Güngör, 2016).

RESULTS

Before CFA, all assumptions were tested. Multivariate normality tests indicated mild kurtosis; therefore, MLR estimation was employed. After removing 12 multivariate outliers, the final sample size was $N = 420$. No missing data were observed.

Confirmatory Factor Analysis

After the pilot application to test the understandability of the scale items, the Digital Fluency Scale for high school students took its final form. In order to use the scale with high school students, it was applied face-to-face on paper to 420 students studying at an Anatolian High School in Eskişehir. The criteria to be considered for fit indices are generally; For GFI, CFI and NFI indexes, .90 indicates acceptable fit, and .95 indicates perfect fit (Marsh *et al*., 2006). For NNFI, a value of .95 is considered acceptable fit, and .97 indicates perfect fit. For AGFI, a value of .85 indicates acceptable fit, and .90 indicates perfect fit (Schermelleh-Engel & Moosbrugger, 2003). In RMSEA, a value of .08 indicates acceptable fit, and .05 indicates perfect fit (Byrne, 1998). For SRMR, .05 is determined as perfect fit, and .10 is determined as acceptable fit (Schermelleh-Engel & Moosbrugger, 2003). The confirmatory factor analysis (CFA) results of the adapted scale are given in Table 2.

Table 2. CFA results of the adapted scale.

Digital Fluency	χ^2 / *df*	RMSEA	SRMR	CFI	TLI	NFI	GFI	AGFI	AIC	ECVI
CFA (Total)	339.9 / 88 = 3.86	.079	.056	.888	.866	.856	.907	.873	403.9	.880

When Table 2 is examined, it is observed that according to the results obtained from the adapted scale, χ^2 / *df* = 3.86, GFI = .907, AGFI = .873, CFI = .888, NFI = .856, TLI = .866, ECVI = .880, SRMR = .056 and RMSEA = .079. The factor loadings of all items are statistically significant. Although the literature generally accepts CFI (Comparative Fit Index) values of .90 and above as acceptable fit and values of .95 and above as good fit (Hu & Bentler, 1999; Marsh *et al*., 2004), some researchers emphasize that CFI values above. Emphasize that CFI values above .80 also indicate acceptable model fit (Chow *et al*., 2001). The CFI value (.888) and RMSEA (.079) indicate that the model meets the minimum acceptable fit thresholds but remains close to the lower limit of adequacy. Following the criteria of Hu and Bentler (1999) and Marsh, Hau, and Wen (2004), these results represent a marginal yet acceptable fit. While not within the ideal range, the overall fit indices (GFI = .907; SRMR = .056) support the structural consistency of the adapted four-factor model. The slightly suboptimal CFI is transparently reported as a limitation, and future research should aim to replicate the model with larger and more diverse samples to confirm its robustness. The suitability of these values obtained was found to be compatible with the reference intervals determined by Munro (2005), Byrne (1998), Tabachnick and Fidell (2013).

CFA results indicated that the path coefficients for all items in the subscales were significant and that factor loadings were at a good level. According to Harrington (2009), factor loadings should be above .30. When Table 3 and Figure 3 are examined, factor loadings for all items of the scale range from .41 to .79, and these values are significant. According to the standardized path coefficients, M3 (β0 = .796) has the highest impact on collaboration and research, M7 (β0 = .728) on digital citizenship, M10 (β0 = .727) on critical thinking, and M15 (β0 = .722) on innovation design. The critical ratio (C.R.) is determined by dividing the parameter estimate by the standard error and should be greater than +1.96 or -1.96 at the .05 significance level (Khine, 2013). The standard error (S.E.) value indicates the difference between the true value of the measured property and the observed measurement result, and the closer it is to zero, the more accurate the estimate (Akbulut, 2022).

The S.E., C.R., and *p* values in Table 3 and Figure 3 meet the desired conditions and indicate that all parameters are statistically significant ($p < .001$). The examined fit indices support the consistency of the four-factor model obtained as a result of CFA and the validity of the factor structure of the original scale in the Turkish sample. The factor loadings of the four-dimensional model according to the first-level CFA results are presented in Figure 3.

Table 3. *Standard and nonstandard path coefficients obtained from the CFA analysis.*

Items	Factor	β_0	β_1	S.E.	C.R.	*p*
I1	IA	.622	1.000			
I2	IA	.737	1.203	.101	11.946	$p < .001$
I3	IA	.796	1.354	.112	12.115	$p < .001$
I4	IA	.695	1.200	.108	11.103	$p < .001$
I5	IA	.454	.826	.102	8.084	$p < .001$
I6	DV	.447	1.000			
I7	DV	.728	1.400	.172	8.161	$p < .001$
I8	DV	.570	1.243	.169	7.354	$p < .001$
I9	DV	.643	1.349	.181	7.461	$p < .001$
I10	ED	.727	1.000			
I11	ED	.680	.888	.069	12.956	$p < .001$
I12	ED	.721	.995	.074	13.526	$p < .001$
I13	YT	.660	1.000			
I14	YT	.416	.694	.094	7.366	$p < .001$
I15	YT	.722	1.100	.094	11.715	$p < .001$

β0 : Standardized path coefficients, β1: Non-standardized path coefficients

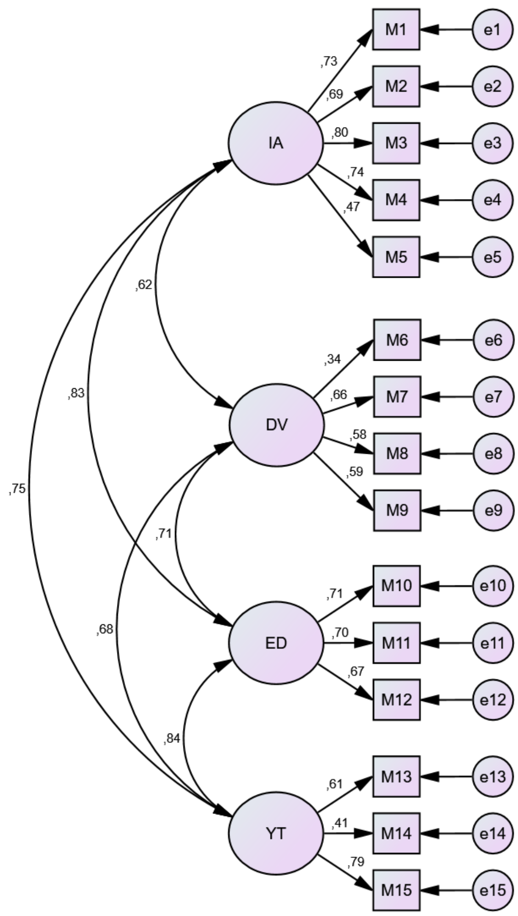

Figure 3. *Path diagram and factor loadings obtained from the first level CFA (Level 1).*
Note. IA: Collaboration and Research; DV: Digital Citizenship; ED: Critical Thinking; YT: Innovation Design

As can be seen in Figure 3, the factor loadings for the "Collaboration and Research" sub-dimension ranged from .47 to .80, while the "Digital Citizenship" sub-dimension showed loading values between .34 and .66. The loading values for the "Critical Thinking" sub-dimension ranged from .67 to .71, while the "Innovation Design" sub-dimension showed loading values between .41 and .79. In addition, it was determined that the correlation values between the dimensions ranged from .62 to .84.

Following the first-level CFA, a second-level CFA was applied to examine the compatibility of the Collaboration and Research, Digital Citizenship, Critical Thinking and Innovation Design sub-dimensions with the general structure, the latent variable called "Digital Fluency". As a result of this analysis, the factor loading values related to the four-dimensional model are presented in Figure 4.

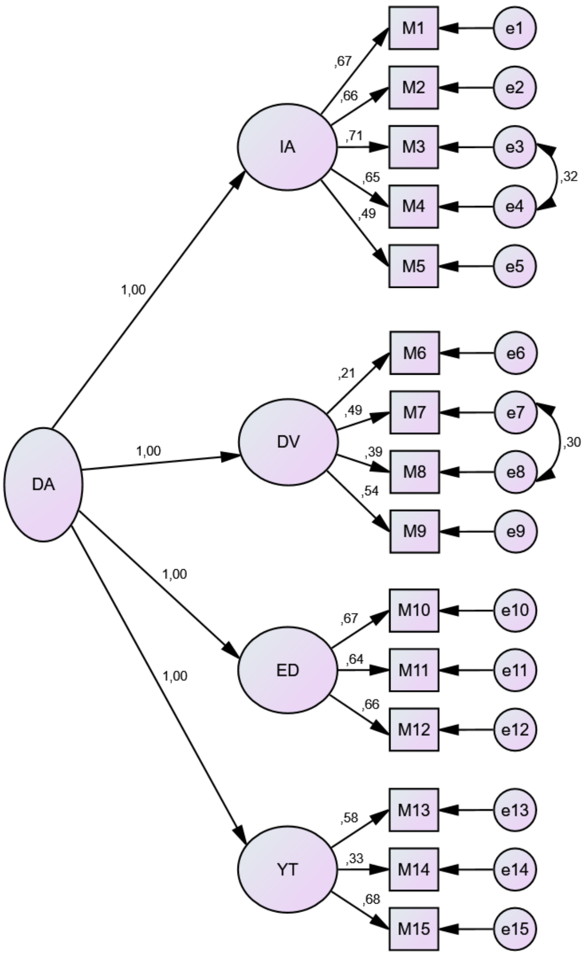

Figure 4. *Path diagram and factor loadings obtained from CFA (Level 2).*
Note. IA: Collaboration and Research; DV: Digital Citizenship; ED: Critical Thinking; YT: Innovation Design

In Figure 4, based on the covariance links created with the AMOS program and the fit indices obtained from these links, it is seen that the scale exhibits a fairly good fit. In the light of these findings, it can be said that Digital Fluency can be measured with a structure consisting of four factors: Collaboration and Research, Digital Citizenship, Critical Thinking and Innovation Design.

For the reliability of the subscales analyzed with CFA, Cronbach's alpha internal consistency coefficients, item-total correlations, and the significance of the differences between the factor and item means of the upper 27% and lower 27% groups were calculated using an independent samples t-test (Table 4). According to the analysis results, the corrected total correlations of the scale items ranged from .36 to .65. The t-test between the item means of the lower 27% and upper 27% groups found that the differences were significant for all items and total subscale scores. This result demonstrates that all items and subscales in the scale are discriminatory.

Table 4. *Item total correlations, and t-test findings between the upper 27% and lower 27% scores.*

Factors	Item	Corrected item-total correlation	*T* (Low%27-High%27)
IA	M1	.546	12.859
IA	M2	.608	13.895
IA	M3	.641	15.885
IA	M4	.575	14.364
IA	M5	.455	12.000
DV	M6	.357	8.274
DV	M7	.611	13.434
DV	M8	.453	9.949
DV	M9	.565	12.572
ED	M10	.651	14.953
ED	M11	.613	14.081
ED	M12	.657	15.579
YT	M13	.599	13.929
YT	M14	.365	9.618
YT	M15	.635	15.149

Reliability

The reliability of the Digital Fluency Scale adapted for high school students was evaluated through Cronbach's alpha coefficients. The alpha values for the sub-factors ranged from .647 to .821, with most exceeding the .70 threshold. The overall scale's Cronbach's alpha was .89, indicating an acceptable level of reliability (Table 5). According to Pallant (2005), reliability coefficients of .70 and above indicate that a scale can be considered reliable. Therefore, the results demonstrate sufficient reliability for both the total scale and its four sub-dimensions. In this context, it can be concluded that the reliability coefficients of the entire Digital Fluency Scale and its sub-dimensions—Collaboration and Research, Digital Citizenship, Critical Thinking, and Innovation Design—meet acceptable standards.

Table 5. Reliability analyses for the total scale and sub-factors.

Scale Dimensions	Number of Item	Cronbach α
Collaboration and Research	5	.82
Digital Citizenship	4	.70
Critical Thinking	3	.75
Innovation Design	3	.64
Total Scale Score	15	.89

Both Cronbach's alpha (α) and McDonald's Omega (ω) were calculated. Omega coefficients ranged from .66 to .84 across subscales, indicating adequate internal consistency consistent with the alpha results.

DISCUSSION and CONCLUSION

In today's society, the demand for individuals who can understand and effectively utilize technology is increasing, highlighting the critical importance of digital fluency. In this context, the aim of the study was to adapt the 15-item Digital Fluency Scale developed by Chou and Chiu (2020) into Turkish. The original scale structure comprises four core dimensions: collaboration and research, digital citizenship, critical thinking, and innovation design. The scale employs a 7-point Likert-type response format, ranging from 'Strongly Disagree' (1) to 'Strongly Agree' (7), and none of its items are reverse-scored. High school students participated in this adaptation study. To test the validity of the original Digital Fluency Scale (DFS) factor structure in a Turkish sample, Confirmatory Factor Analysis (CFA) was conducted on data collected from 420 students. Various fit indices were examined to evaluate the model's adequacy, yielding the following results: χ^2 / *df* = 3.862, RMSEA = .079, GFI = .907, AGFI = .873, CFI = .888, NFI = .856, and SRMR = .056. These values indicate that the model provides adequate fit overall, even though CFI remains just below the .888 to .90 threshold. The present adaptation successfully replicated the original four-factor structure reported by Chou & Chiu (2020) (Collaboration & Research, Digital Citizenship, Critical Thinking, Innovation Design).

Furthermore, the fact that all factor loadings are statistically significant supports construct validity. First-level CFA results showed that in the four-factor model, factor loadings ranged as follows: "Collaboration and Research," .47 to .80; "Digital Citizenship," .34 to .66; "Critical Thinking," .67 to .71; and "Innovation Design," .41 to .79. All sub-dimensions were statistically significant, confirming that the sample size was adequate for factor analysis. A second-level Confirmatory Factor Analysis (CFA) was conducted to examine the extent to which the subscales overlap with a higher-order construct called "Digital Fluency." This analysis revealed that the fit indices were within an acceptable range. Consequently, it was concluded that digital fluency can be evaluated through a four-dimensional structure, namely: collaboration and research, digital citizenship, critical thinking, and innovation design. The fit indices obtained from both the first and second-level CFA support the construct validity of the Turkish version of the scale. Moreover, the high scores on both the subscales and the overall scale suggest that the participants demonstrate a high level of digital fluency.

Cronbach's alpha values were examined to evaluate the reliability of the digital fluency scale adapted for high school students. The alpha coefficients for the sub-factors ranged from .647 to .821, with most exceeding the .70 threshold. The overall scale's Cronbach's alpha was .89, indicating acceptable reliability for both the total scale and its sub-dimensions. These findings provide sufficient evidence for the validity and reliability of the Digital Fluency Scale (DFS) developed by Chou and Chiu (2020) and adapted into Turkish. Furthermore, this scale can be reliably employed in future research to assess digital fluency skills among high school students. The four-factor structure of the original study (digital citizenship, collaboration and research, critical thinking, innovation design) was also confirmed with meaningful factor loadings in the Turkish sample. The load values of the sub-dimensions and the validity/reliability levels of the scale as a whole (α = .89) were found to be high. These results show that digital fluency is perceived and evaluated similarly in both cultures. Below, empirical findings at the subscale and item levels are interpreted, and the results are related to theoretical expectations and previous research.

Collaboration and Research (IA). Factor loadings for this subscale ranged from .47 to .80; items I2–I4 showed particularly strong loadings. These results suggest that Turkish high-school students reliably recognize and self-report collaborative research behaviors when these are framed in familiar classroom tasks (e.g., group projects, digital information synthesis). This aligns with international studies indicating that collaborative digital practices are salient and observable in secondary education (Wang *et al*., 2013). The relatively high item discrimination indicates that these items effectively capture variance in students' collaborative competence. Practically, educators can treat the IA subscale as a sensitive indicator of students' readiness for project-based or inquiry-based digital tasks (Chou & Chiu, 2020).

Digital Citizenship (DV). Loadings for DV varied between .34 and .66, with one item toward the lower bound. Lower loadings may reflect cultural or curricular differences in how digital citizenship is taught and framed in Turkey compared to the Taiwanese context (Chou & Chiu, 2020).

Critical Thinking (ED). Critical Thinking items showed robust factor loadings (.67–.71), indicating that Turkish high-school students can self-assess higher-order cognitive digital skills (e.g., analyzing digital evidence, forming reasoned digital judgments). This is theoretically expected because adolescence is a period of developing meta-cognition and evaluative abilities; thus items tapping reflective and evaluative digital practices manifest more cleanly at the high-school level than at earlier ages (Liu *et al*., 2018). These findings indicate that the Critical Thinking subscale successfully measures the intended cognitive dimension of digital fluency in the Turkish context (Chou & Chiu, 2020).

Innovation Design (YT). YT loadings ranged .41–.79; item I14 exhibited the lowest loading within the instrument. Items measuring imagination about future technologies or speculative design (e.g., "I can imagine new technologies") may be less directly linked to school tasks and therefore produce lower observed variance. However, other Innovation Design items with practical, project-oriented wording (e.g., producing original digital artifacts) loaded strongly, suggesting that when innovation is operationalized through concrete tasks, students reliably report competency. This pattern suggests that minor item phrasing adjustments (to anchor imagination items in concrete classroom experiences) could improve measurement precision in future studies (Chou & Chiu, 2020).

In conclusion, this study successfully adapted Chou and Chiu's (2020) scale to Turkish high school students and demonstrated that it can be used as a valid and reliable tool for measuring digital fluency levels. The findings of this study confirm that the Turkish version of the Digital Fluency Scale retained the structural configuration and latent construct validity of the original model developed by Chou and Chiu (2020). Both first- and second-order CFA results indicate that the four-factor structure (Collaboration and Research, Digital Citizenship, Critical Thinking, and Innovation Design) remains stable, demonstrating strong structural equivalence between the Turkish and Taiwanese versions. Although the CFI value was slightly below the conventional .90 threshold, the model demonstrated overall acceptable fit according to multiple indices. This marginal result likely reflects sample-specific characteristics rather than a structural flaw in the model, but it underscores the need for future replication with broader samples to confirm model stability.

The adaptation process also achieved semantic, idiomatic, experiential, and conceptual equivalence, ensuring that the scale items are culturally and developmentally meaningful for Turkish high school students. This outcome aligns with international recommendations for cross-cultural test adaptation (Hambleton, 2001; ITC, 2017) and supports the universality of the digital fluency construct (ISTE, 2018; Wang *et al*., 2013). Although a formal measurement invariance test (e.g., multi-group CFA) could not be conducted due to the unavailability of the original dataset, this limitation is acknowledged. Nevertheless, the replication of the four-factor model and the satisfactory fit indices obtained in the Turkish sample provide substantial evidence of construct validity and cross-cultural comparability of the adapted instrument.

The results of this study largely replicate the factorial pattern reported by Chou and Chiu (2020), supporting the generalizability of the digital fluency construct across contexts. Differences in specific item loadings (notably in the Digital Citizenship dimension) are consistent with cross-cultural and curricular variability reported in related studies (Hatlevik *et al*., 2015; Porat *et al*., 2018). Compared to teacher- or adult-focused instruments (e.g., scales developed for teacher candidates), our adapted Digital Fluency Scale retains an adolescent-appropriate focus on collaboration and critical thinking while preserving digital citizenship content; this makes the Digital Fluency Scale particularly suitable for secondary-level screening and program evaluation. Where available, the psychometric indices (α, ω, factor loadings) are comparable to other validated digital competence instruments for adolescents, indicating acceptable internal consistency and construct representation.

Theoretically, this findings add to the view that digital fluency is a multidimensional construct manifesting in cognitive, social and productive domains. The replication of a higher-order digital fluency factor confirms that diverse subskills (collaboration, citizenship, critical thinking, innovation) cohere into a broader competence that is meaningful in both Taiwanese and Turkish educational contexts. This cross-contextual replication supports the utility of a parsimonious, 15-item instrument for comparative research and rapid assessment in secondary education. Concretely, our adaptation contributes to the literature by: (1) providing a validated Turkish instrument for high-school students, (2) documenting item-level performance differences that suggest curriculum-sensitive interpretations, and (3) offering psychometric evidence that can inform curriculum designers and researchers engaged in cross-national studies of digital competency.

Future research should examine digital fluency levels in different educational levels, such as elementary school, middle school, university, and teacher samples, in a comparative manner. The adapted scale can be tested in different cultural contexts to evaluate the cross-cultural validity of the digital fluency construct.

Limitations

One limitation of this study is that a formal measurement invariance analysis between the Turkish and Taiwanese datasets could not be conducted because the original data were not accessible. Therefore, the results should be interpreted cautiously in terms of full cross-cultural comparability. Future research should aim to test measurement invariance across different cultures and educational levels to further verify the structural stability and universality of the digital fluency construct. Despite this limitation, the current study provides strong evidence of structural, conceptual, and linguistic equivalence, offering a reliable and culturally relevant tool for assessing high school students' digital fluency.

Acknowledgments

The authors would like to thank Assoc. Prof. Arzu Deveci Topal for her support in data analysis.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the authors. **Ethics Committee Number**: Kocaeli University, 28.12.2022-E.342290.

Data Availability Statement

Research data is available and can be sent with e-mail upon request.

Informed Consent

Written informed consent was obtained from the participants who participated in this study.

Contribution of Authors

The authors contributed equally to the study.

Orcid

Ecem Tunca https://orcid.org/0009-0007-8206-4807
Aynur Kolburan Gecer https://orcid.org/0000-0002-6121-0664

REFERENCES

Akbulut, O. (2022). Bilimsel araştırmalarda istatistiksel anlamlılığın raporlanmasında güncel yaklaşımlar: hatalar ve doğrular [Current Approaches in Reporting Statistical Significance in Scientific Research: Errors and Truths]. *International Journal of Eastern Mediterranean Agricultural Research*, *5*(1), 01-19.

Aksoy, N.C., Karabay, E., & Aksoy, E. (2021). Sınıf öğretmenlerinin dijital okuryazarlık düzeylerinin incelenmesi [Examining the digital literacy levels of classroom teachers]. *Selçuk İletişim, 14*(2), 859-894. https://doi.org/10.18094/josc.871290

Alexander, B., Ashford-Rowe, K., Barajas-Murphy, N., Dobbin, G., Knott, J., McCormack, M., Pomerantz, J., Seilhamer, R., & Weber, N. (2019). *EDUCAUSE Horizon Report: 2019 Higher Education Edition*. EDUCAISE. EDU19. https://www.learntechlib.org/p/208644/

Altunkaynak, M., & Çağımlar, Z. (2023). Türkçe dersinde dijital akıcılığın geliştirilmesi için hazırlanan programın sınıf öğretmenlerinin dijital akıcılıklarına etkisi [The effect of the program prepared to develop digital fluency in turkish classes on the digital fluency of classroom teachers]. *Ana Dili Eğitimi Dergisi*, *11*(3), 580-599. https://doi.org/10.16916/aded.1243661

Borsa, J.C., Damásio, B.F., & Bandeira, D.R. (2012). Cross Cultural adaptation and validation of psychological instruments: Some considerations. *Paidéia*, *22*(53), 423-432. https://doi.org/10.1590/S0103-863X2012000300014

Briggs, C., & Makice, K. (2012). *Digital fluency: Building success in the digital age*. Bloomington, SociaLens.

Blayone, T. (2019). Theorising effective uses of digital technology with activity theory. *Technology, Pedagogy and Education*, *28*(4), 447–462. https://doi.org/10.1080/1475939X.2019.1645728

Büyüköztürk, Ş. (2012). *Sosyal bilimler için veri analizi el kitabı* [Handbook of data analysis for the social sciences]. Pegem Academy Publishing.

Byrne, B.M. (1998). *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: basic concepts, applications, and programming (1st ed.)*. Psychology Press. https://doi.org/10.4324/9780203774762

Calvani, A., Cartelli, A., Fini, A., & Ranieri, M. (2008). Models and instruments for assessing digital competence at school. *Journal of e-Learning and Knowledge Society*, *4*(3), 183-193. https://doi.org/10.20368/1971-8829/288

Chou, Y.C., & Chiu, C.H., (2020). The development and validation of a digital fluency scale for preadolescents. *The Asia-Pacific Education Researcher*, *29*(6): 541-551. https://doi.org/10.1007/s40299-020-00505-1

Chow, J.C.C., Snowden, L.R. & McConnell, W. (2001). A confirmatory factor analysis of the BASIS-32 in racial and ethnic samples. *The Journal of Behavioral Health Services and Research*. *28*(4), 400-411. https://doi.org/10.1007/BF02287771

Coward, M. (2018). Reflection and professional learning. *Nursing Management*, *31*(2): 38-41. https://doi.org/10.7748/nm.2018.e1752

Demir, K. (2018). *Öğretmen adaylarının dijital akıcılıklarının incelenmesi* [Examining the digital fluency of prospective teachers] [Unpublished doctoral dissertation]. Anadolu University.

Dunn, T.J., Baguley, T., & Brunsden, V. (2014). From alpha to omega: A practical solution to the pervasive problem of internal consistency estimation. *British Journal of Psychology*, *105*(3), 399-412.

Eynon, R., & Geniets, A. (2016). The digital skills paradox: How do digitally excluded youth develop skills to use the internet? *Learning, Media and Technology*, *41*(3), 463-479. https://doi.org/10.1080/17439884.2014.1002845

Eshet-Alkalai, Y. (2004). Digital literacy: A conceptual framework for survival skills in the digital era. *Journal of Educational Multimedia and Hypermedia*, *13*(1), 93-106. https://www.learntechlib.org/primary/d/4793

Geisinger, K.F. (1994). Cross-cultural normative assessment: Translation and adaptation issues influencing the normative interpretation of assessment instruments. *Psychological Assessment*, *6*(4), 304-312. https://doi.org/10.1037/1040-3590.6.4.304

Gil-Flores, J., Torres-Gordillo, J.J., & Perera-Rodríguez, V.H. (2012). The role of online reader experience in explaining students' performance in digital reading. *Computers & Education*, *59*(2), 653-660. https://doi.org/10.1016/j.compedu.2012.03.014

Güngör, D. (2016). A Guide to scale development and adaptation in psychology. *Turkish Psychological Articles*, *19*(38), 104-112. https://psikolog.org.tr/tr/yayinlar/dergiler/1031828/tpy1301996120160000m000041.pdf

Hague, C., & Payton, S. (2010). *Digital literacy across the curriculum*. Futurelab. https://www.nfer.ac.uk/media/jnhety2n/digital_literacy_across_the_curriculum.pdf

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate data analysis: A global perspective*. Prentice Hall.

Harrington, D. (2009). *Confirmatory Factor Analysis*. Oxford University Press.

Hambleton, R.K., & Patsula, L. (1999). Increasing the validity of adapted tests: Myths to be avoided and guidelines for improving test adaptation practices. *Journal of Applied Testing Technology*, *1*(1), 1-16. https://api.semanticscholar.org/CorpusID:146275641

Hambleton, R.K. (2001). The next generation of the ITC test translation and adaptation guidelines. *European Journal of Psychological Assessment, 17*(3), 164-172. https://psycnet.apa.org/doi/10.1027/1015-5759.17.3.164

Hamutoğlu, N.B., Güngören, Ö.C., Uyanık, G.K., & Erdoğan, D.G. (2017). Dijital okuryazarlık ölçeği: türkçe'ye uyarlama çalışması [Digital literacy scale: adaptation to turkish]. *Ege Eğitim Dergisi*, *18*(1), 408-429. https://doi.org/10.12984/egeefd.295306

Hatlevik, O.E., Guðmundsdóttir, G.B., & Loi, M. (2015). Digital diversity among upper secondary school students: A multilevel analysis of the relationship between cultural capital, self-efficacy, and digital competence. *Computers & Education*, *81*, 345-353. https://doi.org/10.1016/j.compedu.2014.10.019

Howland, K., & Scott, S.K. (2016). Oral reading fluency testing: Pitfalls for children with speech disorders. *The Reading Teacher*, *69*(6), 653-658. http://dx.doi.org/10.1002/trtr.1441

Hu, L.T. & Bentler, P.M. (1999) Cutoff criteria for fit ındexes in covariance structure analysis: conventional criteria versus new alternatives. *Structural equation modeling: A Multidisciplinary Journal*, *6*, 1-55. http://dx.doi.org/10.1080/10705519909540118

Ince, F. (2022). Digital literacy training: Opportunities and challenges. In M. Taher (Ed.), *Handbook of research on the role of libraries, archives, and museums in achieving civic engagement and social justice in smart cities* (pp. 185-199). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-8363-0.ch009

International Test Commission (ITC) (2017). *ITC guidelines for translating and adapting tests (2nd ed.)*. https://www.intestcom.org

International Society for Technology in Education (ISTE) (n.d.). *ISTE standards: For education leaders*. Retrieved April 8, 2024, from https://www.iste.org/standards/for-education-leaders

Joint Information Systems Committee. (n.d.). *Quick guide: Developing students' digital literacy*. https://digitalcapability.jiscinvolve.org/wp/files/2014/09/JISC_REPORT_Digital_Literacies_280714_PRINT.pd

Khine, M.S. (Ed.). (2013). *Application of structural equation modeling in educational research and practice*. Sense Publishers.

Kim, S., Chung, K., & Yu, H. (2013). Enhancing digital fluency through a training program for creative problem solving using computer programming. *The Journal of Creative Behavior, 47*(3), 171-199. https://doi.org/10.1002/jocb.30

Kozan, M., & Özek, M.B. (2019). Böte bölümü öğretmen adaylarının dijital okuryazarlık düzeyleri ve siber zorbalığa ilişkin duyarlılıklarının incelenmesi [Examining the digital literacy levels and cyberbullying sensitivities of Department of Computer and Instructional Technologies Education teacher candidates]. *Fırat University Journal of Social Sciences*, *29*(1), 107-120. https://doi.org/10.18069/firatsbed.538657

Liu, A., Li, Y., & Ye, H. (2018). Digital fluency and social media use: An empirical ınvestigation of we chat use. In T.X. Bui (Ed.), *Proceedings of the 51st Hawaii international conference on system sciences* (pp. 503-512). HICSS Conference Office. https://doi.org/10.24251/HICSS.2018.065

Lorenzo, G., & Dziuban, C. (2006). Ensuring the Net Generation Is Net Savvy. In D. Oblinger (Ed.), *EDUCAUSE Learning Initiative* (pp. 1-19). EDUCAUSE.

Marsh, H.W., Hau, K.T., Artelt, C., Baumert, J., & Peschar, J.L. (2006). OECD's brief self-report measure of educational psychology's most useful affective constructs: Cross-cultural, psychometric comparisons across 25 countries. *International Journal of Testing*, *6*(4), 311-360. https://doi.org/10.1207/s15327574ijt0604_1

Marsh, H.W., Hau, K.T., & Wen, Z. (2004). In search of golden rules: comment on hypothesis-testing approaches to setting cutoff values for fit ındexes and dangers in overgeneralizing hu and bentler's (1999) findings. *Structural Equation Modeling: A Multidisciplinary Journal*, *11*(3), 320–341. https://doi.org/10.1207/s15328007sem1103_2

Miller, C., & Bartlett, J. (2012). Digital fluency: towards young people's critical use of the internet. *Journal of Information Literacy*, *6*(2), 35-55. http://dx.doi.org/10.11645/6.2.1714

Mudra, H. (2020). Digital literacy among young learners: How do EFL teachers and learners view its benefits and barriers? *Teaching English with Technology*, *20*(3), 3-24. http://files.eric.ed.gov/fulltext/EJ1264169.pdf

Munro, B.H. (2005). *Statistical methods for health care research*. Lippincott Williams & Wilkins.

Murtadho, M.I., Rohmah, R.Y., Jamilah, Z., & Furqon, M. (2023). The role of digital literacy in improving students' competence in digital era. *AL-WIJDÃN Journal of Islamic Education Studies*, *8*(2), 253-260. https://doi.org/10.58788/alwijdn.v8i2.2328

National Research Council, Committee on Information Technology Literacy (1999). *Being fluent with information technology*. The National Academies Press.

Nilsson, J., Gardulf, A., & Lepp, M. (2016). Process of translation and adaptation of the Nurse Professional Competence (NPC) Scale. *Journal of Nursing Education and Practice*, *6*(1), 100-103. http://dx.doi.org/10.5430/jnep.v6n1p100

Pallant, J. (2005). *SPSS survival manual: A step by step guide to data analysis using SPSS for windows*. Australian Copyright.

Pichler, D., & Stehrer, R. (2021). Breaking through the digital ceiling: ICT skills and labour market opportunities (Working Paper No. 193). The Vienna Institute for International Economic Studies. https://wiiw.ac.at/breaking-through-the-digital-ceiling-ict-skills-and-labour-market-opportunities-dlp-5597.pdf

Reddy, P., Sharma, B.N., & Chaudhary, K. (2020). Digital literacy: a review of literature. *Int. J. Technoethics*, *11*, 65-94. http://dx.doi.org/10.4018/IJT.20200701.oa1

Resnick, M. (2012). Mother's Day, warrior cats, and digital fluency: Stories from the Scratch online community. In *Proceedings of the constructionism 2012 conference: Theory, practice and impact* (pp. 52-58). https://web.media.mit.edu/~mres/papers/mothers-day-warrior-cats.pdf

Ribble, M. (2011). *Digital citizenship in schools* (2nd ed.). International Society for Technology in Education.

Schermelleh-Engel, K., & Moosbrugger, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online*, *8*(2), 23-74. https://psycnet.apa.org/record/2003-08119-003

Spante, M., Hashemi, S.S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. *Cogent Education*, *5*(1), 1519143. https://doi.org/10.1080/2331186X.2018.1519143

Sönmez, E.E., & Gül, H.Ü. (2014, November 27-29). *Dijital okuryazarlık ve okul yöneticileri* [Digital literacy and school administrators] [Paper presentation]. 19th Internet Conference of Turkey, İzmir, Türkiye. https://inet-tr.org.tr/inetconf19/ozet/69.html

Şahin, Y. (2023). *Lise öğrencilerinin 21. Yy. Becerileri ile dijital akıcılık düzeyleri arasındaki ilişkinin demografik özellikler bağlamında* incelenmesi [Examining the relationship between high school students' 21st century skills and digital fluency levels in the context of demographic characteristics] [Unpublished Master's Thesis]. Gaziosmanpaşa University.

Tabachnick, B.G., & Fidell, L.S. (2013). *Using multivariate statistics (6th ed.)*. Pearson.

Tunca, E. (2024). *Dijital akıcılık ölçeğinin uyarlanması ve lise öğrencilerinin dijital akıcılık düzeylerinin* incelenmesi [Adaptation of the digital fluency scale and examination of high school students' digital fluency levels] [Unpublished Master's Thesis]. Kocaeli University.

Wang, R., Wiesemes, R., & Gibbons, C. (2012). Developing digital fluency through ubiquitous mobile devices: Findings from a small-scale study. *Computers & Education*, *58*(1): 570-578. https://doi.org/10.1016/j.compedu.2011.04.013

Wang, Q., Myers, M.D., & Sundaram, D. (2013). Digital natives and digital ımmigrants towards a model of digital fluency. *Business & Information Systems Engineering*, *55*(6), 409-419. http://dx.doi.org/10.1007/s11576-013-0390-2

APPENDIX

Appendix 1. *Digital Fluency Scale - Turkish version (Dijital Akıcılık Ölçeği).*

İ.A 1.	Çeşitli görevler ve problemler için uygun dijital kaynakları seçip kullanabilirim.
İ.A 2.	Çeşitli kaynaklardan ve medyadan bilgiyi bulabilir, düzenleyebilir, analiz edebilir, değerlendirebilir, sentezleyebilir ve etik olarak kullanabilirim.
İ.A 3.	Deney veya araştırma yapma stratejilerini planlamama yardımcı olan dijital araçları kullanabilirim.
İ.A 4.	Deney ve araştırma sonuçlarını işlemek, analiz etmek ve raporlamak için dijital araçları kullanabilirim
İ.A 5.	Çevrimiçi bir öğrenme ortamında iş birliğine dayalı bir öğrenme projesine katılabilirim.
D.V 6.	Çevrimiçi ortamda karşılaştığım farklı cinsiyet, yaş ve etnik kökene sahip insanlara saygı duyabilirim.
D.V 7.	İşbirliğini, öğrenmeyi ve üretkenliği destekleyen teknolojiyi kullanmaya yönelik olumlu bir tutum sergileyebilirim.
D.V 8.	Sınıf arkadaşlarımı ve aile üyelerimi, bilgi ve teknolojiyi güvenli, yasal ve sorumluluk alabilecek şekilde kullanmaya teşvik edebilirim.
D.V 9.	Mevcut ve gelişmekte olan teknolojilerin bireyler ve toplum üzerindeki etkisini tartışabilirim.
E.D 10.	Bir projeyi tamamlamak veya bir çözüm geliştirmek için faaliyetleri planlamak ve yönetmek için dijital araçları kullanabilirim.
E.D 11.	Dijital araçları farklı bakış açılarıyla alternatif çözümler araştırmak için kullanabilirim.
E.D 12.	Teknolojik kaynaklar ile toplanan verilere dayanarak bilinçli kararlar alabilir veya çözümler belirleyebilirim.
Y.T 13.	Dijital araçlardan yararlanarak kişisel veya ekip olarak özgün çalışmalar yapabilirim.
Y.T 14.	Gelecekte karşımıza çıkabilecek yeni teknolojik ürünleri hayal edebilirim.
Y.T 15.	Projeleri tamamlamak için yeni fikirler, ürünler veya süreçler oluşturmak amacıyla dijital araçları kullanabilirim.