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RESEARCH ARTICLE

Digital Teaching Skills in Distance Education Scale: A Validity and Reliability Study*

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What is already known about this topic?

- *Distance education is a communication and interaction process that eliminates spatial and temporal limitations between learners and teachers.*
- *Digital technologies are an important element in revealing the targeted potentials of learners and teachers in distance education.*
- *The Digital Competence of Educators ("DigCompEdu") competence framework developed within the scope of the European Qualifications Framework is a framework that tries to provide a common understanding of educators' digital competencies.*

What does this study add to this topic?

- *A new measurement tool, Digital Teaching Skills in Distance Education Scale (DTSDES), has been proposed to decipher the digital skills of teachers in distance education.*
- *The adaptation of the teacher qualifications in the DigCompEdu competence framework to distance education environments has been examined.*
- *The validity and reliability of DTSDES have been tested.*

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Abstract

The present study attempts to design a valid and reliable instrument for measuring the digital teaching skills of secondary school teachers in distance education. For this descriptive validity and reliability study, Istanbul-based secondary school teachers were recruited through cluster sampling in the 2022–2023 academic year. Before item polling, the relevant literature was meticulously reviewed, and secondary school teachers' opinions concerning their distance education experiences were elicited. The Lawshe technique was applied using the opinions of 11 field experts to ensure content validity of the scale based on the European Framework for the Digital Competence of Educators. Next, the 5-point Likert-type draft form was administered to 12 teachers prior to the pilot study. Construct validity of the scale was then tested through exploratory and confirmatory factor analysis with two different samples of 476 and 246 participants, respectively. The internal consistency coefficient was calculated as 0.919 for the total score, 0.898 for the professional engagement subscale, 0.744 for the student support/empowerment subscale, and 0.857 for the measurement-evaluation subscale. In a nutshell, the 23-item Digital Teaching Skills in Distance Education Scale was found to be a valid and reliable instrument to be employed in the Turkish distance education context. In this regard, it is anticipated that prospective researchers and practitioners will benefit from the Digital Teaching Skills in Distance Education Scale and contribute to the distance education literature.

Keywords: Distance education, digital competence, digital teaching skills, Lawshe technique, scale development, secondary school teachers

Introduction

From the distant past to the present, people have been affected by a multitude of political, economic, and cultural changes, as well as being exposed to several undesirable events, including floods, earthquakes, pandemics, natural disasters, and wars. The resulting experiences have compelled them to redefine their current needs. Similarly, teaching and learning processes have undergone a significant transformation on a global scale with emergency distance education applications in the wake of the Coronavirus-19 (COVID-19) pandemic. As Taşkan (2021) notes, the exclusive requirements mandated by the pandemic, coupled with the current focus on digitalization in contemporary societies, have led to a proliferation of distance education applications.

Distance education refers to teaching and learning processes through digital technology and online platforms, allowing students and teachers to engage and interact remotely despite spatial and temporal restrictions (Harry et al., 1993). Face-to-face pedagogical practices were inevitably affected by the philosophical approach of distance education during the COVID-19 pandemic. In this sense, new roles and responsibilities have emerged for learners and teachers on the eve of the transition from traditional classroom-based education to distance learning (Hodges et al., 2020). The scenario where teachers and learners have endeavored to engage in teaching and learning activities in the absence of a classroom setting (Moorhouse, et al., 2020) has led nations to assess their educational capacity in the context of potential epidemics and disasters in the forthcoming years (Hodges et al., 2020). Hence, the advent of new paradigms in response to the mentioned circumstances has led to the incorporation of technology-oriented transformation in national education policies, accelerating the transition from face-to-face education to distance education (Adedoyin & Soykan, 2020; Creed & Morpeth, 2014).

In its inherent nature, distance education lacks a structured program and is often adopted in cases with insufficient personnel and financial resources (Sokal, et al., 2020). It has, therefore, emerged as a viable

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alternative for urgent and unanticipated scenarios, such as the COVID-19 pandemic. In this regard, the initiatives to reap distance education with digital technology are likely to guide the revisiting of educational policies at the national level (Baysal-Doğruluk, 2023).

The 21st-century literacy entails more than the ability to read, write, and calculate. The prevalence of virtual environments for almost every domain of life presents individuals with the necessity to possess at least a degree of digital skills (Schrum, et al., 2016; Som-Vural, 2016; Slavin, 2014). Indeed, all stakeholders of education, including school administrators, teachers, students, and parents, need to demonstrate fundamental digital literacy competencies to secure an enhanced learning experience (Vilchez et al., 2021).

It is evident that the education ecosystem is preparing for the digital transformation era; yet, insufficient knowledge and skills to utilize digital technologies among learners prevent them from fully capitalizing on digital opportunities (Redecker, 2017). It is therefore critical to nurture the digital skills of teachers who prepare students to navigate the digital era (Instefjord & Munthe 2015; Starkey, 2019). The extant literature indicates that teachers with inadequate digital competencies encounter challenges in integrating digital tools into their routine pedagogical practices (Kirschner & Davis, 2003; Silva, et al., 2019; Petko, 2012).

It is claimed that enhancing teachers' digital skills is essential for fostering active and continuous learning among 21st-century learners (Maderick et al., 2016), leading to devising a multitude of digital competence models/frameworks for educators. Among the most widely recognized models is the European Framework for the Digital Competence of Educators (DigCompEdu), designed as part of the European Qualifications Framework (Sillat, Tammets & Laanpere, 2021). As outlined in DigCompEdu, educators should possess proficiency in digital teaching skills pertinent to distance education, including professional engagement, interaction and communication, classroom management, utilization of digital resources, emerging roles for teachers in the digital age, ethics in the digital domain, data protection, and the reinforcement of learners' digital competencies, and measurement and evaluation.

Despite the prevalence of discourse on distance education in the literature, there remains a paucity of conceptual research exploring teachers' digital teaching skills in distance education. Therefore, the present study attempts to design a valid and reliable instrument—the Digital Teaching Skills in Distance Education Scale (DTSDES)—for measuring secondary school teachers' digital teaching skills in distance education. It is considered significant because of its potential contribution to the existing literature and its applicability to diverse samples.

Method

The present study was conducted upon ethical approval from the Publication Research and Ethics Committee of Marmara University (No:04-09 Date: April 10, 2023). Throughout the research, all rules specified in the "Directive of Scientific Research and Publication Ethics in Higher Education Institutions" were strictly followed. The directive's second section, titled "Acts Against Scientific Research and Publication Ethics," was not subject to any infractions. Moreover, the rules concerning scientific integrity, ethical conduct, and citation were followed while drafting the manuscript; no falsification was made on the collected data. This study has not been submitted for evaluation to any other academic publication platform. Informed consent (Consent to Participate and Consent to Publish) was obtained from all participants. All participants were secondary school teachers, and no participant was under 18 years of age.

Research Design

This study employed a descriptive design to explore the validity and reliability of the DTSDES. A descriptive research design is employed to describe the characteristics of the group of interest and to identify how the group is distributed in one or among more variables (Fraenkel & Wallen, 2003).

Sample

The target population consisted of teachers serving in state secondary schools in Istanbul in the second semester of the 2022–2023 academic year. Using stratified cluster sampling, participants were selected from each type of secondary education in Türkiye—Vocational and Technical Anatolian High School (VTAHL), Anatolian Imam Hatip High School (religious vocational school; AIHHS), and Anatolian High School (AHL)—to boost the diversity of the sample (Karasar, 2015). While testing the construct validity of the scale, exploratory factor analysis (EFA) was performed using data from a group of 476 participants, and confirmatory factor analysis (CFA) was performed using data from another group of 246 participants. These participants' demographic characteristics are presented in Table 1.

Data from 476 teachers were used for the EFA. Of these participants, 291 (61.14%) were females and 185 (38.86%) were males. Regarding school type, 165 participants (34.66%) were employed in AHL, 159 (33.40%) in VTAHL, and 152 (31.94%) in AIHHS. Confirmatory factor analysis was performed using data from 246 teachers. In this analysis, the distributions of female (n=134, 54.47%) and male participants (n=112, 45.53%) were similar. Among these participants, 83 (33.74%) were employed in AHL, 87 (35.37%) in VTAHL, and 76 (30.89%) in AIHHS.

Data Collection and Analysis

Data were collected during the second semester of the 2022–2023 academic year. Based on the statistical procedures recommended in the relevant literature (Aksu, et al., 2014; Balcı, 2007; Büyüköztürk, 2005; Metin, 2014; Tezbaşaran, 2002), a six-phase process was followed to explore the validity and reliability of the DTSDES.

Phase 1: Theoretical Framework and Scope

In this phase, theses/dissertations and scholarly papers on secondary school teachers' digital teaching skills in distance education were comprehensively reviewed, with particular attention given to reports and studies conducted by governmental and independent organizations. An assessment tool for the mentioned purpose was subsequently developed based on DigCompEdu (Redecker, 2017). This framework, comprising 22 competencies in six distinct areas pertinent to educators, served as the theoretical framework for the DTSDES.

Phase 2: Item Pooling

To create an item pool, six teachers with previous experience in distance education were invited to submit their reflective essays on

Table 1.
Demographics of Participants in EFA and CFA

Variable		Analysis	*n*	%	Analysis	*n*	%
Gender	Female	EFA	291	61.14	CFA	134	54.47
	Male		185	38.86		112	45.53
	Total		476	100		246	100
School type	AHL		165	34.66		83	33.74
	VTAHL		159	33.40		87	35.37
	AIHHS		152	31.94		76	30.89
	Total		476	100		246	100

Note: AHL=Anatolian High School; AIHHS=Anatolian Imam Hatip High School; CFA=confirmatory factor analysis; EFA=exploratory factor analysis; VTAHL=Vocational and Technical Anatolian High School.

their pertinent experiences. Through content analysis, insights into the potential scale items were derived from these documents. A preliminary version of the DTSDES consisting of 83 items, encompassing both positive and negative statements, was then developed. In addition, a minimum of 3 items was ensured to represent each competency within DigCompEdu.

Phase 3: Expert Opinions

To investigate the content validity of the draft form, the Lawshe technique (Lawshe, 1975) was applied to expert opinions. This technique comprises six stages: identifying the expert group, developing a draft form, eliciting expert opinions, calculating content validity ratios (CVR) for the items, calculating content validity index (CVI) for the scale, and finalizing the scale based on the content validity criterion/coefficient (CVC). This technique requires opinions from 5–40 experts (Yurdugül, 2005).

In the formula above for CVR, while n_e represents the number of experts indicating the item is "relevant," N refers to the total number of experts providing their opinions on the items. The CVR value is quantifiable between −1 and 1. Should the CVR value be zero or negative, the item is to be removed from the scale. The positivity of the CVR value for any item indicates that that item can be tested at $\alpha = 0.05$. The CVI, on the other hand, is derived from the mean CVR value of the remaining items. It is then compared with CVC, and the item with a value below the cut-off CVC value is then removed from the scale. The CVR ≥ CVC suggests that the content validity of the remaining items is statistically significant (Akdağ, 2022). In this study, cut-off CVC values were determined based on the table designed by Veneziano and Hooper (1997). Accordingly, the minimum values in Table 2 indicated the content validity of the items are statistically significant.

To elicit their content validity evaluation, the 83-item draft form, along with a rubric allowing assessment of each item as "relevant," "not relevant," or "needs correction," was emailed to a total of 11 experts. Of these experts, ten were academics in the fields of curriculum and instruction (CI), computer education and instructional technology (CEIT), measurement and evaluation (ME), and distance education (DE), whereas one was employed as a linguist. The experts and their fields of expertise are summarized in Table 3.

The CVR value of each item marked as "relevant" by experts was calculated using the Lawshe technique. No zero or negative CVR value were identified for any item, and the cut-off for 11 experts was adopted as 0.59, as previously recommended (Veneziano & Hooper; 1997). Accordingly, 36 items with a CVR value below the cut-off CVC value were removed. In addition, several items were revised based on expert opinions. The mean CVR values was then calculated as 0.79. Since the CVR ≥ CVC condition was satisfied, the content validity of the remaining 47 items was significant (Table 4).

Table 2.
Minimum CVC Values for CVRs

Number of Experts	Minimum Value	Number of Experts	Minimum Value
5	0.99	13	0.54
6	0.99	14	0.51
7	0.99	15	0.49
8	0.78	20	0.42
9	0.75	25	0.37
10	0.62	30	0.33
11	0.59	35	0.31
12	0.56	40+	0.29

Table 3.
Experts' Fields of Expertise

Expert	Title	Field of Expertise	Expert	Title	Field of Expertise
E1	Professor	CI	E7	Associate professor	ME
E2	Associate professor	CI	E8	Associate professor	ME
E3	Assistant professor	CI	E9	Assistant professor	ME
E4	Assistant professor	CI	E10	Professor	DE
E5	Associate professor	CEIT	E11	Assistant professor	DE
E6	Instructor	CEIT	E12	Professor	Linguist

Note: CEIT = Computer Education and Instructional Technology; CI = curriculum and instruction; DE = distance education; ME = measurement and evaluation.

Phase 4: Preliminary Testing and Pilot Study

The 5-point Likert-type draft form consisted of 36 positive and 11 negative (reverse-coded) statements, and the items were randomly sorted prior to preliminary testing. The draft form was administered to a group of 12 teachers to assess response time and item clarity. Following the required ethical approvals and permissions from the relevant organizations, the pilot study was initiated with 476 teachers, representing approximately 10 times the number of items. Finally, the data were transferred to SPSS 21.0 and LISREL 8.8 for EFA.

Phase 5: Factor Analysis

For construct validity concerns, EFA was first performed using data of 476 participants to reveal the factorial structure of the scale and item-factor loadings. Before the procedure, 11 items in the draft form (items 10, 13, 18, 23, 24, 25, 26, 28, 36, 40, and 47) were reverse coded.

The item-factor loading was deemed to be 0.40 or greater to eliminate additional items and obtain a more concise structure. Moreover, the items were rotated using the Varimax method to handle items

Table 4.
Item CVR Values After Lawshe Analysis

Item	CVR	Item	CVR	Item	CVR	Item	CVR
I1	0.09	I22	0.09	I43	0.45	I64	0.63
I2	0.81	I23	0.09	I44	0.45	I65	0.99
I3	0.81	I24	0.45	I45	0.99	I66	0.63
I4	0.09	I25	0.09	I46	0.81	I67	0.81
I5	0.45	I26	0.45	I47	0.63	I68	0.63
I6	0.45	I27	0.27	I48	0.99	I69	0.27
I7	0.27	I28	0.45	I49	0.45	I70	0.81
I8	0.27	I29	0.27	I50	0.27	I71	0.99
I9	0.99	I30	0.99	I51	0.81	I72	0.81
I10	0.99	I31	0.63	I52	0.45	I73	0.63
I11	0.27	I32	0.09	I53	0.09	I74	0.45
I12	0.63	I33	0.45	I54	0.45	I75	0.99
I13	0.63	I34	0.81	I55	0.45	I76	0.63
I14	0.81	I35	0.63	I56	0.81	I77	0.63
I15	0.45	I36	0.81	I57	0.81	I78	0.27
I16	0.45	I37	0.99	I58	0.63	I79	0.99
I17	0.81	I38	0.99	I59	0.63	I80	0.99
I18	0.45	I39	0.63	I60	0.63	I81	0.45
I19	0.63	I40	0.81	I61	0.81	I82	0.09
I20	0.63	I41	0.45	I62	0.45	I83	0.63
I21	0.81	I42	0.45	I63	0.81		

Note: CVR = content validity ratios.

irrelevant to each other and reduce the number of items. Consequently, the analysis yielded a 23-item 3-factor form of the DTSDES.

To test the 3-factor structure of the DTSDES identified through EFA, CFA was performed using data from another group of 246 participants. In this procedure, the 11 items were also reverse coded. Overall, the CFA results confirmed the 3-factor, 23-item structure of the DTSDES.

Phase 6: Reliability Analysis

For reliability concerns, Cronbach's α coefficients were calculated for the total and subscale scores. Accordingly, the DTSDES total and subscale scores yielded sufficiently high internal consistency.

Results

This section presents the findings of EFA, CFA, and reliability assessment of the DTSDES.

Exploratory Factor Analysis Findings

The initial Kaiser–Meyer–Olkin (KMO) and Bartlett's test of sphericity statistics yielded pertinent evidence indicating the suitability of the data for EFA (KMO = 0.952; $\chi 2$ = 11492.37, *df* = 1081, *p* = .000; Tavşancıl, 2002). Exploratory factor analysis was then performed using principal component analysis in a total of 10 iterations. While KMO and sphericity statistics after each iteration are demonstrated in Table 5, Table 6 shows the findings at the end of the final EFA iteration.

In the end of the EFA iterations, the final KMO and sphericity statistics showed the suitability of the data for EFA (KMO = 0.899; χ^2 = 2272.29, *df* = 253, *p* = .000). It should be noted that, in each iteration, items with factor loading values below 0.40, overlapping items, and semantically inconsistent items were removed from the scale. The final results uncovered a three factor strcture with an eigenvalue >1 that explained 53.41% of the total variance. These three factors explained at least 36.55%, 10.47%, and 6.39% of the variance, respectively. Thus, the final version of the DTSDES was determined to comprise 23 items within 3 subscales.

While the scree plot of the final EFA iteration of the scale is given in Figure 1, factor loadings of the items are presented in Table 7. The

Table 5.
Kaiser–Meyer–Olkin and Sphericity Statistics in Each EFA Iteration

Iteration	KMO Statistic	Bartlett's Test of Sphericity
1	0.952	(χ^2 = 11492.37, *df* = 1081, *p* = .000)
2	0.934	(χ^2 = 4878.95, *df* = 253, *p* = .000)
3	0.913	(χ^2 = 5848.60, *df* = 1081, *p* = .000)
4	0.908	(χ^2 = 4269.57, *df* = 703, *p* = .000)
5	0.901	(χ^2 = 3426.29, *df* = 528, *p* = .000)
6	0.899	(χ^2 = 3278.09, *df* = 496, *p* = .000)
7	0.902	(χ^2 = 2930.34, *df* = 406, *p* = .000)
8	0.902	(χ^2 = 2584.51, *df* = 325, *p* = .000)
9	0.896	(χ^2 = 2326.53, *df* = 276, *p* = .000)
10	0.899	(χ^2 = 2272.29, *df* = 253, *p* = .000)

Note: KMO = Kaiser-Meyer-Olkin.

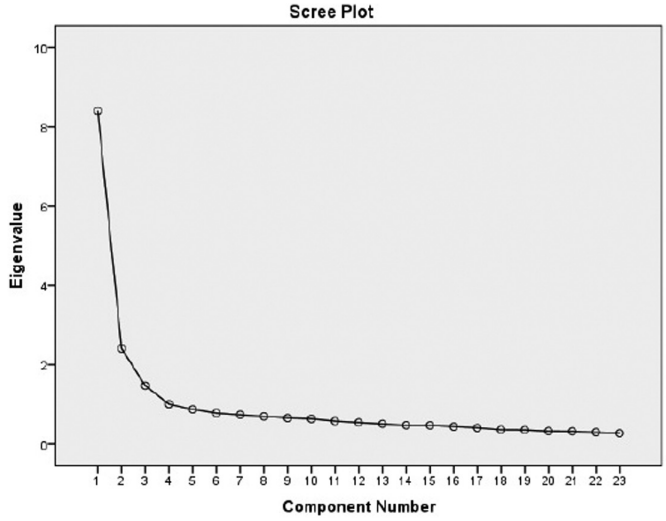


Figure 1.
Scree Plot for the DTSDES.

EFA results for the DTSDES were considered sufficient to explain the digital teaching skills of secondary school teachers in distance education in the Turkish context.

On the DTSDES, 13 items (items 15, 22, 19, 30, 29, 14, 20, 32, 27, 38, 16, 9, and 7) are clustered under the first factor, 5 (items 24, 28, 23, 26, and 10) under the second factor, and 5 under the third factor (items 42, 41, 44, 35, and 43). Among them, 5 items (items 10, 23, 24, 26, and 28) are reverse scored. As previously highlighted, three corresponding domains in DigCompEdu were identified to designate factors: professional engagement, measurement-evaluation, and student support/empowerment. While professional engagement encompasses teachers' reflective practice, digital continuous professional development, professional collaboration, and organizational communication skills in distance education, the measurement-evaluation domain refers to teachers' skills in assessment strategies, providing feedback and planning, and analyzing findings in distance education. Teachers' student support/empowerment skills denote their skills in accessibility and inclusion, differentiation and personalization, active student engagement, information and media literacy, communication, content creation, responsible use, and problem-solving in distance education.

Statements in this 23-item scale are scored on a 5-point Likert-type scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). The total and subscale scores are calculated through the summation of all item scores and subscale item scores, respectively. Accordingly, participant scores range between 23–115 for the DTSDES, 13–65 for the professional engagement subscale, and 5–25 for the student support/empowerment and measurement-evaluation subscales. It can be reasonably inferred that while higher total scores indicate an enhanced capacity for digital teaching skills in distance education, higher subscale scores imply a heightened competence among participating teachers in the corresponding domain. The DTSDES scores can also be utilized to categorize secondary education teachers' skills in distance education.

Table 6.
Exploratory factor analysis Findings of DTSDES

Data Suitability	Excluded Items*	Total Variance Explained (%)	Variance Explained by Each Factors** (%)
KMO = 0.899	I1, I2, I3, I4, I5, I6, I8, I11, I12, I13, I17, I18, I21, I25, I31,	53.41	36.55
Bartlett's Test of Sphericity	I33, I34, I36, I37, I39, I40, I45, I46, I47		10.47
(χ^2 = 2272.29, *df* = 253, *p* = .000)			6.39

*Items with a communality < 0.40, overlapping items, and semantically inconsistent items. **Factors with an eigenvalue > 1.
Note: KMO = Kaiser–Meyer–Olkin.

Table 7.
Factorial Structure of the DTSDES and Item-Factor Loadings

Item No.	Item	Professional Engagement	Measurement-Evaluation	Student Support/ Empowerment
I15	I can provide assistance to my colleagues in the utilization of digital resources (e.g., Web 2.0 tools, online course materials) in distance education.	0.771		
I22	I am adept at presenting course content in various formats (e.g., Web 2.0, interactive boards) in distance education.	0.755		
I19	I can assist students in resolving technical challenges in distance education.	0.755		
I30	I can use appropriate digital resources (e.g., digital apps, interactive content) to enhance student learning in distance education.	0.733		
I29	I can utilize digital storage spaces to store my course materials in distance education.	0.705		
I14	I can formulate effective lessons for distance education.	0.683		
I20	It is not challenging for me to record my classes in distance education.	0.646		
I32	I can ensure that my students can conveniently access digital content in distance education.	0.638		
I27	I possess the pedagogical competence to design digital content for diverse age groups in distance education.	0.584		
I38	I can develop valid and reliable measurement-evaluation tools in distance education.	0.539		
I16	I can inform students about their liabilities that may arise from any violations.	0.500		
I9	I can utilize reinforcers in distance education.	0.440		
I7	I can collaborate with my colleagues on digital designs for distance education.	0.434		
I24	It is challenging for me to obtain student feedback in distance education.		0.824	
I28	It is challenging for me to analyze if my students can fully understand subject matters in distance education.		0.793	
I23	It is challenging for me to engage in measurement-evaluation in distance education.		0.786	
I26	It is challenging for me to provide feedback and corrections to my students using digital tools in distance education.		0.711	
I10	It is challenging for me to get my students to engage in practice in distance education.		0.639	
I42	I can communicate with my students through various verbal expressions and symbols (e.g., emojis, gifs) in distance education.			0.723
I41	I can plan content sensitive to my students' individual needs in distance education.			0.668
I44	I am diligent in ensuring equal student participation in my classes in distance education.			0.653
I35	I consider student demands/requests to ensure their engagement in distance education.			0.625
I43	I can provide adequate feedback to my students in distance education.			0.617

For example, the score ranges of 23–53, 54–85, and 86–115 indicate teachers' "poor," "moderate," and "advanced" digital teaching skills, respectively. Similarly, the mentioned criteria apply to the score ranges of 13–30, 31–48, and 49–65 on the professional engagement subscale and 5–11, 12–18, and 19–25 on the student support/empowerment and measurement-evaluation subscales.

Confirmatory Factor Analysis Findings

Confirmatory factor analysis was performed using data of another sample of 246 teachers to test the 23-item 3-factor structure yielded by EFA. The first CFA iteration in the Lisrel program suggested modification indices between items 7–9 and 30–32. Connecting error terms of two variables with a high modification index is claimed to contribute to the model-data fit of the construct (Jöreskog & Sörbom, 1993). In the replicated analysis, the suggested modifications between the relevant items were performed, and the conceptual model of the DTSDES was finalized. While the conceptual model is presented in Figure 2, Table 8 exhibits model-data fit indices.

The CFA yielded a $\chi 2$ value of 517.40 with 225 degrees of freedom for the model, resulting in a $\chi 2/df$ ratio of 2.29, which was statistically significant ($p < .05$). A $\chi 2/df$ ratio below 3 is often claimed to indicate a perfect model-data fit (Jöreskog & Sörbom, 1993; Sümer, 2000; Kline, 2005). The analysis also showed a root mean square error of approximation (RMSEA) value to be 0.073 for the model. It is assumed that the RMSEA value is acceptable between 0.05–0.08, perfect between 0.00–0.05, and unacceptable at values of 0.080 and above (Pallant, 2020). Similarly, acceptable adjusted goodness of fit index (AGFI) and GFI (>0.80) were obtained. Moreover, the model produced perfect incremental fit index IFI and comparative fit index (CFI) values (>0.95) (Bentler, 1990; Hu & Bentler, 1999; Sümer, 2000). Overall, the factor analyses in this study allowed us to explore and confirm the 23-item 3-factor model of the DTSDES.

Reliability Analysis

For reliability concerns, the internal consistency of the DTSDES total and subscale scores was examined (Table 9).

Cronbach's α was calculated as 0.919 for the total score, 0.898 for the professional engagement subscale, 0.744 for the student support/empowerment subscale, and 0.857 for the measurement-evaluation subscale. As a rule of thumb, an α coefficient greater than 0.70 indicates a high internal consistency of the measurement tool (Tavşancıl; 2002).

In general, the 23-item DTSDES was considered a valid and reliable measurement tool for assessing secondary school teachers' digital teaching skills in distance education within the Turkish context.

Discussion

The ultimate aim of this study was to develop a tool to measure secondary education teachers' digital teaching skills in distance education. To this end, the conceptual structure of the instrument was devised based on the relevant literature, opinions from 11 experts, and data obtained from 722 secondary school teachers. A series of statistical analyses was then employed to evaluate the instrument's validity and reliability. The resulting tool, the 23-item 3-factor DTSDES, is presented here.

The DTSDES bears three factors with an eigenvalue above 1, accounting for 53.41% of the total variance, in a sample of Turkish

secondary education teachers. The additional variances attributable to

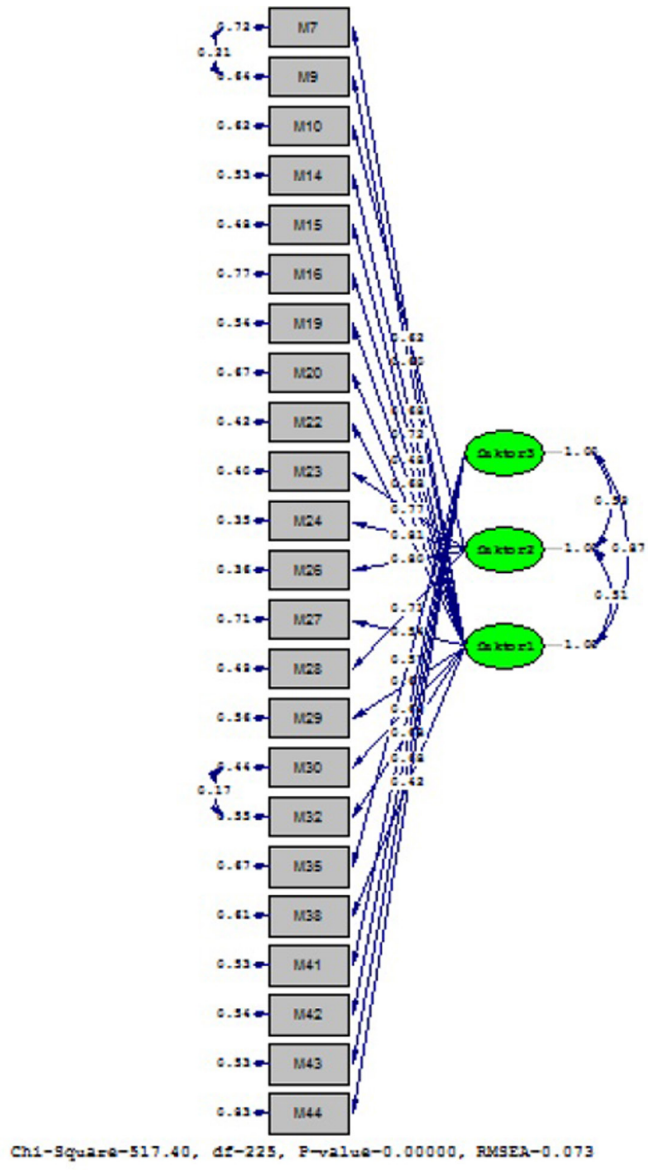


Figure 2.
Conceptual Model of the DTSDES.

the three factors are at least 36.55%, 10.47%, and 6.39%, respectively. In addition, the reliability analysis suggests Cronbach α to be 0.919 for the total score, 0.898 for the professional engagement subscale, 0.744 for the student support/empowerment subscale, and 0.857 for the measurement-evaluation subscale. Thus, the scale demonstrates a high level of internal consistency. The 23-item 3-factor structure initially identified through EFA is now confirmed by the results of CFA on the data from an independent sample of Turkish teachers. Given the model-data fit indices above, the conceptual model of the DTSDES was considered to demonstrate an acceptable-to-good fit with the data.

Table 8.
Model-Data Fit Indices of the DTSDES

χ^2	*df*	(χ^2/*df*)	RMSEA	IFI	CFI	AGFI	GFI
517.40	225	2.29	0.073	0.97	0.97	0.81	0.84

Note: AGFI=adjusted goodness of fit index; CFI=comparative fit index; GFI=goodness of fit index; IFI=incremental fit index; RMSEA=root mean square error of approximation.

Table 9.
Internal Consistency of the DTSDES Total and Subscale Scores

Scale	No. of Items	Cronbach's α
Professional Engagement	13	0.898
Student Support/Empowerment	5	0.744
Measurement-Evaluation	5	0.857
DTSDES Total Score	23	0.919

The professional engagement component of the DTSDES encompasses teachers' reflective practice, digital continuous professional development, professional collaboration, and organizational communication skills in distance education. The prominent areas of focus within distance education include the utilization of digital platforms and technological tools, the resolution of technical issues, the creation and management of digital content, the formulation of effective course designs, and the recording of instructional sessions. Concerning their professional engagement skills, teachers may need in-service training before or amid their deployment in distance education, with a particular focus on enhancing their abilities in the mentioned areas. In a recent study, Kocatürk-Kapucu (2023) identified communication and collaboration, openness to innovation, and continuous professional development (i.e., seeking to participate in seminars and conferences) as the most crucial aspects of teachers' professional engagement in distance education. Parlak-Aras (2023) also underscored the significance of possessing adequate proficiency in the utilization of digital tools, communication with colleagues, parents, and students, and participation in online professional activities as components of professional engagement in digital education. In another study, Olpak (2023) concluded that continuous professional development is essential for educators to enhance their digital competence, that the utilization of technological resources is a significant part of their professional engagement, and that effective communication with learners through digital platforms is integral to their professional practice. In addition to the findings above, there is a body of literature suggesting a necessity for educators to engage in ongoing professional development and employ digital resources to cultivate their digital competence in distance education (Erbenzer, 2021; Şanlı, 2022; Yener, 2022).

Recommendations

The student support/empowerment component of the DTSDES denotes their skills in accessibility and inclusion, differentiation and personalization, active student engagement, information and media literacy, communication, content creation, responsible use, and problem-solving in distance education. In this sense, student support/empowerment in distance education cannot be thought of as independent of efficient teacher-student communication, formulation of content sensitive to learners' individual needs, integration of their needs into the teaching-learning process, provision of support education for those with special needs and consistent feedback for all, and responsiveness to students' demands and requests. A review of the literature shows guidance of learners with special needs in utilizing digital resources, engaging in one-to-one online communication with learners, encouraging the use of applications that facilitate peer communication, and using online question-answer applications among teachers' student support/empowerment skills in distance education (Kocatürk-Kapucu, 2023). It is also emphasized that online projects and assignments, application-based activities (Parlak-Aras, 2023), applications enhancing learner experience, and activities promoting collaborative learning are instrumental in fostering learner engagement. (Erbenzer, 2021; İlter-Tutar, 2023; Olpak, 2023).

The measurement-evaluation component of the DTSDES encompasses teachers' skills in assessment strategies, feedback and planning, and analysis and interpretation of data in distance education. In this study, the most prominent skills of teachers to be measured in this domain appear as their ability to utilize both traditional and alternative/

authentic measurement-evaluation techniques, to develop valid and reliable measurement tools while conducting process- and result-oriented evaluations, and to regulate these measurement-evaluation practices. The utilization of e-assessment tools in distance education should be intertwined with process- and result-oriented assessment approaches covering collaborative assessment practices, assessments through online homework and projects, and course attendance tracking (Akşan-Kılıçaslan et al., 2022; Kocatürk-Kapucu, 2023). It is also emphasized that teachers engaged in distance education need to possess advanced skills to design Web 2.0 tools and valid and reliable online measurement tools and to use digital platforms for providing effective feedback (Erbenzer, 2021; Parlak-Aras, 2023).

Conclusion

In summary, the DTSDES can be administered to educators engaged in distance education across Türkiye (or other countries). It can serve as a valuable data collection instrument to generate a map of "Teachers' Digital Teaching Skills in Distance Education," which will guide distance education policy and pave the way for far-reaching intervention studies. Besides, the present study can be considered a model for research design, sampling, and data collection and analysis in future scholarly work to attempt to measure any construct within distance education. Prospective researchers may also deploy diverse research designs to introduce novel instruments or to modify the DTSDES to bring further insights into teachers' digital teaching skills in distance education.

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