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Research Article

Digital leadership in educational organizations: A scale adaptation study

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Abstract: In this study, it was aimed to adapt the DigiFuehr 2.0 Scale developed by Claassen *et al.* (2023) to Turkish and to conduct validity and reliability studies on three groups of participants consisting of teachers. In the study, exploratory and confirmatory factor analyses were performed in line with translation study, linguistic application, and validity and reliability studies. The findings indicate that the scale is a valid and reliable assessment tool for Turkish education leaders. In particular, the dimensions of support and self-organization play an important role in evaluating the digital leadership skills of leaders. In addition, this scale provides a powerful tool for evaluating and developing the digital leadership skills of educational leaders. Therefore, it will allow a more in-depth examination of the effects of digital leadership skills in studies to be carried out in educational organizations.

1. INTRODUCTION

Leadership, a phenomenon that has attracted attention throughout human history, is an important concept in the context of the growth, development and struggle for the survival of organizations. Looking at leadership from a broad perspective, Yukl (2009) pointed out that the individual motivation, abilities, and power relations of the group members affect the perception of leadership, as well as interpreting leadership as the group's reactions to internal and external influences. In the twenty-first century, a dramatic change was observed in the relations between school principals and teachers within the framework of leadership and management. According to Tanniru and Peral (2021), the main reason for this change is the political, social, economic and technological changes that have occurred in educational organizations in the twenty-first century and have significantly affected these organizations. These changes have led to a change in school management and understanding of leadership. According to Figus (2021), new technologies that can dynamically change and transform society and schools have paved the way for the transformation of educational policies and the understanding of individuals, groups and leaders in the organization.

When we consider educational organizations, it is important for students, teachers and all organizational employees to gain personality and individualize, to keep up with change and

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transformation, to understand the modern world and to keep up with the modern world. In other words, technology and digitalization have ceased to be a choice or choice for 21st century managers, learners and teachers and have become a necessity (Ceylan, 2019). According to Zhong (2017), while school structures that try to keep up with the transformation started to progress physically, they also tried to get rid of the classical school understanding by improving their technological infrastructures. During this time, schools managed in line with the bureaucratic structure have led scientists to research and develop alternative forms of management in order to keep up with digital transformation and catch up with technology (Richardson *et al.*, 2012). Thus, changing living conditions in the globalizing world have begun to develop school management styles and leadership styles. Individuals who can keep up with change in school organizations, provide all kinds of technological development for the school and have the knowledge and experience to both develop and support themselves and all employees of the organization exhibit an impressive leadership example (Antonopoulou *et al.*, 2020; Tanniru *et al.*, 2018).

In the new century, organizations need to integrate common knowledge, experience, judgment, values and beliefs and transform at the group and organization level with digital leaders in order to benefit from the information stacks according to the needs of the age (Rooney & McKenna, 2007). Based on this context, it can be said that it is not possible for educational organizations not to be affected by digital education technologies. However, it can be stated that administrators, teachers and students use technological devices effectively in their lives outside of school. Therefore, it is impossible to keep educational organizations away from digital media and tools. For this reason, digital tools are expected to be actively used in other processes of management as well as teaching activities.

The rapid changes of the digital age are radically transforming educational organizations and taking the understanding of leadership to a new dimension. Traditional education models, together with the rise of digital technologies, affect learning processes and corporate governance. In this context, the concept of digital leadership in educational organizations has evolved into a broad perspective that not only emphasizes technological skills, but also includes features such as managing change, encouraging innovation, and strengthening the learning culture (Arham *et al.*, 2023). In short, it is an inevitable reality that digital tools are used more and more effectively every day in educational organizations. In summary, in order for educational organizations to reach organizational wisdom, it is expected that leaders who will succeed in using digital technologies for the benefit of the organization will play an important role in addition to phenomena such as information management and digital leadership.

Digital leadership in educational organizations has a critical role in managing modern learning environments. Ridho *et al.* (2023) express this leadership style as the ability to effectively integrate digital technologies, increase student success, and reshape educational processes. However, it can be said that digital leaders have a vision to use technology strategically in educational institutions. However, digital leaders enrich the learning experience by interacting with students, teachers, and even all stakeholders through advanced learning and teaching systems, online platforms, and other digital tools (Yusof *et al.*, 2019). According to Highton (2022), these leaders also provide support to teachers in developing digital skills. It encourages innovative practices in education and leads teachers to use the potential provided by technology more effectively.

It can also be said that school administrators with digital leadership characteristics are skilled in obtaining scientific outputs in educational organizations. Thus, digital leaders can use data analysis, output evaluation and monitoring processes to achieve the studies conducted in schools and the targeted level of success (Karaköse *et al.*, 2021). The outputs obtained in line with these processes are used for the analysis of data on student achievement, the improvement of teaching processes and the creation of individualized

learning strategies. As digital leaders communicate effectively, they can enable all stakeholders of the organization to participate more in decision-making processes and gain self-confidence (Tigre *et al.*, 2023). Thus, it is assumed that digital leaders in education can also increase student-parent communication. Based on this assumption, digital communication tools allow parents to provide instant information about their students' progress and success, which more effectively engages families in the learning processes.

Despite these benefits of digital transformation and leadership in educational organizations, it can be observed that there are some negative situations encountered. Lack of technological infrastructure in educational organizations, inadequate access to technology; school administrators' lack of general digital skills or feeling inadequate in digital skills may create obstacles to implementing digital leadership and effectively transferring digital skills to teachers and students (Sousa *et al.*, 2017). Similarly, insufficient training and support for teachers to perform digital leadership tasks may cause a lack of skills in this regard. In addition, the commitment of administrators and teachers to traditional teaching methods may cause them to resist adopting technology (Keleş *et al.*, 2020). This may prevent the effective fulfillment of digital leadership roles. In addition, the general financial problems of schools can create difficulties in investing in new technological solutions and providing financial support for the digital development of educational staff. In our world of rapid technological transformation, the inability to integrate new technological tools and applications into the learning environment may reduce the motivation of all stakeholders of educational organizations. In this context, it is thought that it is important for teachers to be able to evaluate their basic digital skills, communication and cooperation skills, adaptation skills to change, and innovation and creativity capacities. In addition, it can be stated that the fact that teachers have a say in the determination of school management and education policies and have the opportunity to work with leaders who can support digital learning, change and transformation is a critical point not only for educational organizations but also for the digital development of society. In this context, it is hoped that the outputs of the digital leadership scale, which has been adapted, will be a valuable tool for school leaders to make strategic decisions for teachers to understand and develop their digital skills. In this way, it is thought that educational institutions can be directed to a more effective digital transformation process and offer stronger digital learning experiences to all stakeholders.

In this study, it was aimed to adapt the DigiFuehr 2.0 Scale, originally developed by Claassen *et al.* (2023) to evaluate the digital leadership level of individuals and their managers, into Turkish and to conduct validity and reliability studies of the Turkish form on a group of teachers. The DigiFuehr 2.0 Scale allows for the analysis of not only individual leadership skills but also both horizontal and vertical leadership approaches, providing a broader understanding of digital leadership culture (Claassen *et al.*, 2023). Such scales assess the roles and competencies of individual leaders in digital transformation processes while also measuring how leaders participate in collaboration and decision-making processes within the organization (Petry, 2018). These features are particularly important for educational institutions, as digital leadership is not limited to the use of technology by administrators; it also encompasses the development of digital skills among teachers, students, and other stakeholders (Highton, 2022).

One of the reasons for adapting the DigiFuehr 2.0 scale to the Turkish context is the increasing digitalization initiatives in Turkey's education system in recent years. In particular, the digital education infrastructures accelerated by the pandemic have made it imperative for teachers and administrators to develop their digital leadership skills (Karaköse *et al.*, 2021). Measuring the digital leadership levels of educational administrators will provide a strategic perspective on Turkey’s digital transformation

processes in education. Therefore, the DigiFuehr 2.0 scale is a suitable and effective tool for assessing the digital competencies of educational leaders in Turkey.

Developed by Claassen *et al.* (2023), the DigiFuehr 2.0 scale evaluates the contributions of not only a single administrator but also all members of the organization to the role of digital leadership, emphasizing both horizontal and vertical leadership aspects of digital leadership culture. Particularly with the widespread digitalization of educational institutions, such an assessment tool allows for a comprehensive evaluation of leaders' digital skills (Rooney & McKenna, 2007). In this respect, it is expected that the adaptation of the scale will make a significant scientific contribution, particularly for education systems like Turkey's, which are in the process of digital transformation.

2. METHOD

2.1. Research Method

The Digital Leadership Scale (DigiFuehr 2.0) was developed by Claassen *et al.* (2023) to evaluate his and his manager's level of digital leadership. Before starting the studies, the authors who developed the scale were asked for permission to adapt the scale. In the process of adapting the scale to Turkish, (1) a translation study and (2) a validity and reliability study were conducted. The Digital Leadership Scale was applied to the workstation employees of municipalities in Germany when it was first developed. In contrast, the scale was adapted by applying a different sampling (teachers). Confirmatory factor analysis and exploratory factor analysis methods were used during the validity study of the scale. The exploratory factor analysis method was used because the researcher did not have an idea about the factor structures during the development or adaptation of the scale, and the scale adaptation needed scientific evidence (Finch & West, 1997). SPSS Statistics 22 and Amos 24 software were used for the study.

2.2. Translation Study

During the translation study, the support of expert linguists was obtained. The items used in the scale were translated into Turkish by a lecturer who speaks Turkish and English well, two faculty members and three doctoral students. Then, translation options were evaluated by a faculty member and four experts from the field of educational administration and different translations were decided. The decided scale items were examined by three Turkish language and literature experts in terms of meaning and fiction integrity and Turkish spelling check before the pilot application. The recommendations given by these experts were applied on the scale. Later, the back translation process of the scale items translated into Turkish was carried out by two associate professors and a doctor faculty member, who were different from the experts who made the first translation process and had a command of both languages. Finally, the scale, which was translated into English, was compared by two experts and the differences that may occur were resolved. The last edited Digital Leadership Scale was applied to a group of 50 educators. As a result of the pilot study, it was understood that the scale items were understandable and clear to the participants.

2.3. Participant Groups

During the adaptation of the Digital Leadership Scale to Turkish, three separate sample groups consisting of teachers working actively in public, and private schools and institutions participated in the study.

2.3.1. *First group*

This group was the one from which data on Exploratory Factor Analysis (EFA) were obtained. This group consisted of 310 participants including 181 female (58.4%), 129 male (41.6%), 248 undergraduate (80%), and 62 (20%) graduate-doctorate teachers.

2.3.2. *Second group*

This second group was the one from which data on Confirmatory Factor Analysis (CFA) were obtained. This group consisted of 183 participants including 60 female (32.8%), 123 male (67.2%), 131 undergraduate (71.6%), and 52 (28.4%) graduate-doctorate teachers.

2.3.3. *Third group*

It is the group where the data related to the Test-Retest were obtained. In this group, it was aimed to test the consistency of the scale against time. The scale was applied to this group twice with an interval of 15 days. This group consisted of 63 participants including 24 female (38.1%), 39 male (61.9%), 44 undergraduate (69.8%), and 19 (30.2%) graduate-doctorate teachers.

2.4. Data Collection Tool

Digital Leadership Scale: It is a scale originally called DigiFuehr 2.0 developed by Claassen *et al.* (2023), which aims to measure the digital leadership culture at the team level, including horizontal leadership, instead of evaluating the competence of a single leader or non-leader. The concept of digital leadership is defined as a process of development and transformation (Petry, 2018). Therefore, in addition to digital demands and support for managers, the assumption that the entire organization has responsibilities in this regard and that every employee can be considered as a digital leader over time is a prevailing opinion (Ahlemann *et al.*, 2021). DigiFuehr 2.0, developed in this context, is a four-point Likert-type scale consisting of nine items and two sub-dimensions. The support sub-dimension consists of items (2, 3, 4, 5, 6, 7) that measure how much the individual is encouraged and supported for his/her digital development. The self-organization sub-dimension consists of the items expressing the participation of the person in the intra-organizational decisions related to him/herself (item 1), the ability of the person to make his/her own decisions within the organization (item 8) and his/her involvement in the intra-organizational coordination (item 9). The internal consistency of the scale was found to be α=0.88 throughout the scale. In the adaptation study, the scale was adapted as a five-point Likert type and it was determined that the highest score obtained from the scale would be 45 and the lowest score would be 9. A high score indicates a high level of digital leadership skills and perception, while a low score indicates a low level of digital leadership skills and perception. The finalization of the Turkish version of the scale for implementation (see the Turkish version of the DLS in the Appendix).

2.5. Data Analysis

In the study, SPSS for Windows 22.0 and Amos 21.0 package software were used for statistical analysis of the data obtained from the scale. For the internal consistency of the scale, the Cronbach Alpha coefficient was calculated for both sample groups in general and separately for each dimension. For the content validity of the scale, the opinions of experts in the field were consulted, while exploratory factor analysis was applied to the first sample group for construct validity, and confirmatory factor analysis was applied to the second sample group. Kaiser-Meyer-Olkin (KMO) and Bartlett (Bartlett's Test of Sphericity) tests were performed before the Exploratory Factor Analysis was performed. As a result of the KMO (= .923) and Bartlett (= 2338.354, p = .000) tests, exploratory factor analysis was deemed appropriate because the KMO value higher than .60 showed that the data were suitable for factor analysis (Büyüköztürk, 2014).

While conducting Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), the normality assumption of the data set was based on the assumptions that skewness and kurtosis values should be between +1 and -1 and Z scores should be between +3 and -3 (Çokluk *et al.*, 2012). As a result of the analyses, it was found that the data sets in both EFA and CFA studies were normally distributed. The reliability of the scale was tested using Cronbach's alpha and composite reliability (CR) over the data collected for EFA. An α value above 0.7 is considered acceptable (Büyüköztürk, 2014). The discrimination power of the items

was examined by comparing the upper 27% and lower 27% of the data with the corrected item-total correlations (Can, 2018). SPSS 22.0 software was used for composite reliability, Cronbach's alpha, construct validity and item analysis of the Digital Leadership Scale.

Lastly, measurement invariance was examined using multi-group confirmatory factor analysis (MG-CFA) (Cheung & Lau, 2012; Horn & McArdle, 1992). Measurement invariance provides information on the psychometric equivalence of a construct across groups or over time (Putnick & Bornstein, 2016). In this study, measurement invariance was tested at the configural, followed by the metric, and finally the scalar levels of measurement invariance (Cheung & Rensvold, 2002; Vandenberg & Lance, 2000).

3. RESULTS

As a result of the exploratory factor analysis, the support dimension explains 64.24%of the total variance and the self-organization dimension explains 13.28% of the total variance. Cronbach Alpha internal consistency coefficients of the Digital Leadership Scale were calculated as .957 in the support dimension, .738 in the self-organization dimension, and .929 in the entire scale. In light of these data, it can be said that the self-organization dimension is reliable, and the support dimension and the entire scale are highly reliable (Yang & Green, 2009). The results obtained as a result of the exploratory factor analysis are shown in Table 1.

Table 1. *Exploratory factor analysis results.*

Dimension	Articles	Factor I	Factor II	Factor Common Variance	Corrected Item-Test Correlation
		Support	Self-Organization		
Support	2. My school principal supports me to improve my digital literacy.	.854		.817	.851
	3. When I have problems with digitalization, I get support from my school principal.	.857		.781	.805
	4. I regularly receive feedback from my school principal on the quality of my digital work.	.865		.800	.823
	5. My school principal supports me in accessing the information I need to do my digital work.	.878		.850	.867
	6. My school principal supports me in understanding and using digital applications better.	.896		.859	.858
	7. My principal promotes digital ways of working at school.	.863		.835	.861
Self-Organization	1. I am involved in decisions that affect my work and digital work environment.		.631	.529	.546
	8. I can determine what working methods, processes, and solution approaches I will use to accomplish my tasks.		.794	.718	.569
	9. I perform my duties in cooperation with my colleagues.		.881	.788	.443
	Eigenvalue	5.782	1.196		
	Total Variance Explained (77.525)	*64.241*	*13.284*		
	Cronbach's Alpha	*.957*	*.738*		
	Cronbach Alpha (for the full scale)		*.929*		

Cronbach's alpha coefficients for each dimension of the scale are .96 for the support dimension (6 items), .74 for the self-organization dimension (3 items) and .93 for the total scale. The CR coefficients for the support and self-organization dimensions are .94, .82 and .86 for the total scale. In general, reliability coefficients of .70 and above are presented as evidence that measurement tools can be accepted as reliable (Fraenkel *et al.*, 2012). Composite Reliability (CR) and AVE were used to test the convergent validity of the scale. All CR values related to the scale are expected to be greater than the AVE values and the AVE value is expected to be greater than 0.5 (Hair *et al.*, 2019). In this respect, the AVE values of the scale were found to be at an acceptable level.

Cronbach's alpha (α) and composite reliability (CR), AVE coefficients for each dimension of Dijital Ledaership Scale were used to assess the reliability of the Digital Leadership Turkish version. The results are shown in Table 2.

Table 2. *Digital Ledaership Scale Cronbach's alpha (α), CR and AVE values*.

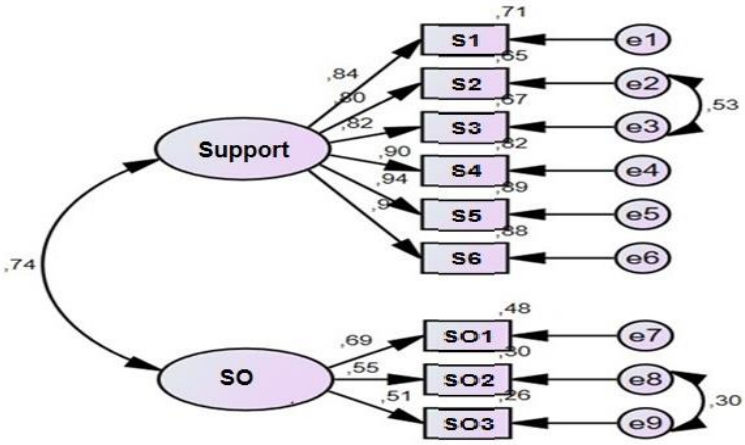
Dimension	Cronbach's α	Composite Reliability (CR)	AVE
Support (6 item)	.96	.94	.76
Self-Organization (3 item)	.74	.82	.60

After the exploratory factor analysis results, data were collected from the second sampling group (n=183). According to Fidell and Tabachnick (2003), criteria such as missing data, univariate and multivariate normality, linearity, outlier observations, and multiple linear connection problems should be examined in the data set before applying statistical analysis. As a result of the analysis, it was determined that there was no lost or missing data. The number of data collected for confirmatory factor analysis was determined as 183. In order to perform the confirmatory factor analysis, it is stated that 100-200 people are required according to Boomsma (1985), and the sample size should be larger than 100 according to Anderson and Gerbing (1984). Some researchers state that the sample size needed depends on the number of items. According to Cohen and Cohen (1983), a minimum of 10 participants are recommended for each item, and according to Stevens (2002), between 5-20 participants are recommended for each item on the scale. In light of this information, it can be said that the sample size of the research is sufficient for analysis. However, skewness and kurtosis values were calculated for each item, Variance Increase Factor (VIF), Tolerance (T), and Status Index (CI) values were examined and whether there was normality and multicollinearity in the data set was tested. In line with the findings obtained, it was observed that CI values were less than 30, VIF values were less than 10, and T values were different from zero, so multicollinearity assumption was provided (Black and Babin, 2019) and confirmatory factor analysis was performed.

While performing confirmatory factor analysis, many fit data were checked. According to these data, it can be said that CFI, NNFI and GFI values mean a perfect fit greater than .95, good fit between .95 and .90 (Bentler & Bonett, 1980); RMSEA, RMR and SRMR values below .05 mean a good fit level, acceptable level up to .08 (Browne & Cudeck, 1992), AGFI value is a good fit if a value greater than ".95", values greater than ".85" mean acceptable fit (Yılmaz & Çelik, 2009). Firstly, model fit statistics were determined without any limitation in the model created. According to the analyzes, χ^2 = 114.29, sd = 260, χ^2/sd = .439 (p = .00) , RMSEA = .137, NNFI = .91, CFI = .93, GFI = .87, AGFI = .78, RMR = .07 and SRMR = .048. In the light of these data, the modification indices were examined in order for the model to fit better, the items S2 and S3 and SO2 and SO3 were reviewed, it was determined that these items were meaningfully close to each other and measured similar properties, and necessary arrangements were made. As a result of repeated analysis, new data; χ^2 = 51.59, sd = 24, χ^2/sd = 2.15 (p = .01) , RMSEA = .07, NNFI = .96, CFI = .98, GFI = .94, AGFI = .88, RMR = .04 and SRMR = .032. In this way, it can be said that the data fit the model better. Cronbach Alpha internal consistency coefficients of the Digital Leadership Scale were calculated as .957 in the support

dimension, .738 in the self-organization dimension, and .929 in the entire scale. In light of these data, it can be said that the self-organization dimension is reliable, and the support dimension and the entire scale are highly reliable (Yang & Green, 2009). The analysis diagram showing the data obtained for the confirmatory factor analysis is shown in Figure 1 together with the standard coefficients.

Figure 1. *Confirmatory factor analysis.*



The scale, which reached its final form as a result of the analyzes, was applied to a group of 63 teachers every 15 days. As a result of the application of the Digital Leadership Scale to the same sample group of teachers at 15-day intervals, the correlation between the sub-dimensions of the scale and the scores obtained from the scale total was obtained as .918 in the self-organization dimension, .852 in the support dimension, and .887 in the scale total. In light of these data, it can be said that the test-retest reliability of the scale is high. The data regarding the test-retest application of the Digital Leadership Scale are given in Table 3.

Table 3. *Digital Leadership Scale test-retest application.*

		2. Application (Cronbach Alpha= .923)		
		Self-Organization	Support	Scale Total
1. Application (Cronbach Alpha= .915)	Self-Organization	.918		
	Support		.852	
	Scale Total			.887

Looking at the item analysis results, when 27 was taken as the cut-off value (lower and upper groups), the results showed that the t-values for the difference between the upper 27% and lower 27% of the participants ranged between 3.56 and 7.46 for the self-organization dimension and between 4.24 and 7.14 for the support dimension. The t-test values are significant for all items according to the comparison between the lower 27% and the upper 27% of the participants. Significant t-values in the comparisons between the lower and upper groups of the participants were accepted as evidence of the discriminative power of the items (Büyüköztürk, 2014). Table 4 also shows that item-total correlations ranged between .44 and .87. When the results obtained are evaluated together, it is concluded that each item of the Digital Leadership Scale is discriminative.

The item analyses of the scale were conducted with Item-Test Correlation methods and Sub-Upper Group Analysis techniques (Büyüköztürk, 2014). A t-test was used to determine whether there was a significant difference between the upper 27% and the lower 27% of the Turkish version of the Digital Leadership Scale. The results of the item analysis of the scale are given in Table 4.

Table 4. *Item analysis results of Digital Leadership Scale*.

Dimension	Items	Corrected Item Total Correlations (r)	*Upper (%27)* $\bar{X}$	Lower (%27) $\bar{X}$	Lower-Upper 27% *t*-Test	*p*
Support	2. My school principal supports me in developing my digital literacy.	.851	2.28	1.58	4.24	.00
	3. Whenever I have problems with digitalization, I get support from my school principal.	.805	2.38	1.42	5.31	.00
	4. I regularly receive feedback from my school principal about the quality of my digital work.	.823	2.42	1.38	5.76	.00
	5. My school principal supports me in accessing the information I need to do my digital work.	.867	2.59	1.66	6.30	.00
	6. My school principal supports me in understanding and using digital applications better.	.858	2.40	1.52	5.85	.00
	7. My school principal encourages digital working methods at school.	.861	2.85	1.47	7.14	.00
Self-Organization	1. I am involved in decisions that affect my job and my digital work environment.	.546	3.25	2.45	3.83	.00
	8. I can determine which work methods, processes and solution approaches I will use to accomplish my tasks.	.569	2.67	1.67	7.46	.00
	9. I fulfill my duties in cooperation with my colleagues.	.443	3.88	3.02	3.56	.00

Before conducting the measurement invariance analyses, the model fit indices of the original factor structure of the Digital Leadership Scale by gender and subject area are presented in Table 5. When Table 5 is examined, it is evident that the fit indices of the measurement model of the Digital Leadership Scale for the gender and subject area variables fall within the widely accepted ranges used to evaluate model fit in the literature. In this context, the two-factor structure of the Digital Leadership Scale demonstrates compatibility with the data obtained from all subgroups. In other words, the original factor structure has been confirmed for each subgroup, providing evidence that construct validity is established within each subgroup.

Table 5. *Fit indices of the subgroups for the Digital Leadership Scale.*

Groups		χ^2	*sd*	RMSEA (%90 CI)	SRMR	CFI	TLI
Gender	Female	111.55	251	.068 (.065 - .071)	.040	.96	.95
	Male	114.32	251	.069 (.065 - .072)	.038	.95	.94
Branch	Primary School Teacher	135.68	2240	.059 (.039 - .078)	.038	.97	94
	Specialist Teacher	158.95	224	.079 (.060 - .098)	.051	.95	.92

Note: df = degrees of freedom, and the 90% confidence intervals for the RMSEA values are provided in parentheses.

Whether the Digital Leadership Scale holds measurement invariance across gender and subject area variables was examined using multi-group confirmatory factor analyses. In this context, configural, metric, and scalar invariance models were tested for each variable. The findings related to measurement invariance are presented in Table 6.

Table 6. *Multi-group CFA results for the Digital Leadership Scale.*

Variable		χ^2	*sd*	RMSEA	CFI	SRMR	$\Delta\chi^2$	Δsd	*p*	ΔCFI	ΔRMSEA	ΔSRMR
Gender	Formal	264	98	.071	.964	.036						
	Metric	274.73	106	.067	.959	.043	15.23	9	.08	.003	.002	.008
	Scalar		117	.066	.958	.045	14.59	9	.13	.002	.002	.002
Branch	Formal	267.41	98	.071	.957	.037						
	Metric	276.95	106	.066	.954	.042	8.48	9	.48	.002	.001	.002
	Scalar	290.98	117	.066	.954	.043	13.95	9	.13	.000	.000	.001

When Table 6 is examined, it can be said that the fit indices used to evaluate model fit for the configural invariance stage are within acceptable limits for all groups (RMSEA < .08, CFI > .90, NFI > .90, NNFI > .90, IFI > .90). Since the factor loadings, inter-factor correlations, and error variances of the model are freely estimated across subgroups in the configural invariance stage, it can be stated that the structure of the measurement model for the Digital Leadership Scale is the same across gender and subject area subgroups. As configural invariance was achieved, the next stage, metric invariance, was tested.

In the metric invariance stage, the factor loadings were constrained to be equal across subgroups. The fit indices obtained were examined, and the model was found to exhibit good fit with the data. To test metric invariance, the differences between the CFI and RMSEA values from the configural and metric invariance stages were examined, and it was observed that the ΔCFI and ΔRMSEA values were within acceptable limits for metric invariance (ΔCFI ≤ .01; ΔRMSEA ≤ .015). This finding indicates that the factor loadings of the variables in the model did not change across gender and subject area subgroups. After metric invariance was established, the final stage of scalar invariance was tested by constraining the factor structures, factor loadings, and item intercepts to be equal across groups.

The fit indices for scalar invariance indicated that the model exhibited adequate fit. Scalar and metric invariance models were compared, and it was determined that the obtained values remained within the criteria recommended by Chen (2007). The findings from the model comparisons demonstrate that the Digital Leadership Scale achieved configural, metric, and scalar measurement invariance across both male and female teachers, as well as between primary school teachers and subject teachers.

4. DISCUSSION and CONCLUSION

Digital leadership in education is a critical factor for the sustainable success of educational institutions in today's rapidly changing technological environment. Digital leadership in education contributes to the professional development of teachers and school administrators, playing a key role in adapting them to the rapidly changing digital age. Today, technological advances have profound effects on the success of educational institutions, and at this point, digital leadership guides teachers, students, and parents in using digital tools effectively (Levin & Schrum, 2013; Robiah & Nurdin, 2021; Sheninger, 2019). Studies emphasize that teachers' digital leadership skills play an important role in supporting technology integration in the classroom, increasing student motivation, and strengthening teaching strategies (Levin & Schrum, 2013; Robiah & Nurdin, 2021; Sheninger, 2019).

In this context, research tools such as the Digital Leadership Scale are an important resource for evaluating and developing the digital leadership skills of teachers and school administrators (AlAjmi, 2022). Digital leadership provides a framework that guides school administrators, teachers, and other stakeholders in the process of integrating educational technologies (Sheninger, 2019). This leadership approach allows teachers to create student-centered learning environments in their classrooms and use digital tools effectively (Ertmer *et al.*, 2006).

With this important role in education, digital leadership helps students develop their digital skills and prepare them for the future digital world (Bersin, 2018). Therefore, it is emphasized by many studies that digital leadership enriches the interaction and learning experience in education by supporting the professional development of teachers and school administrators (Levin & Schrum, 2013; Robiah & Nurdin, 2021; Sheninger, 2019). For this reason, the Digital Leadership Scale, which can be used for educational organizations, has been adapted because it is worth further examination in terms of the role of digital leadership in education, student success, teaching strategies and its impact on technology integration.

This study focused on evaluating the validity and reliability of the digital leadership scale on Turkish education leaders. The findings show that the scale is compatible with the Turkish education system and can be a reliable tool for evaluating digital leadership skills of leaders. The high factor loads obtained in the support dimension of the study emphasize the effective role of leaders in increasing the level of digital literacy and improving the quality of digital studies (AlAjmi, 2022). In addition, in the research on the role of digital leadership in education in the literature, Arham *et al.* (2022) found that digital leadership has a positive effect on teacher and student success. From this point of view, it is thought that future studies that examine the effect of leader behaviors in the support dimension on student success in more detail will contribute to educational organizations.

The capacity of leaders to effectively support students and teachers in digitalization can positively affect the digital transformation process in education (Hakansson *et al.*, 2019). AlAjmi (2022) emphasizes that self-organization skills are important for the effective management of digital learning environments. Similarly, studies by Cvetković *et al.* (2023) examining the effects of digital leadership on increasing student achievement show that this scale can guide educational leaders in developing digital leadership skills. In the light of this information, it is seen that the items in the self-organization dimension evaluate the participation of leaders in digital decisions and the self-regulation skills required to effectively fulfill their duties. This emphasizes the importance of leaders focusing on their personal and professional development in order to fulfill their digital leadership roles more effectively (Gierlich-Joas *et al.*, 2020).

In summary, the study of adapting the Digital Leadership Scale to Turkish confirmed the validity and reliability of the scale on Turkish education leaders. This supports that the digital leadership scale can be used as an effective assessment tool for educational leaders. The findings indicate that the internal consistency and factor structure of the scale are strong. The

high factor loads of the items in the support dimension emphasize the effective role of leaders in improving digital literacy and increasing the quality of digital studies. Items in the self-organization dimension, on the other hand, revealed that leaders can measure the self-regulation abilities necessary for them to be included in digital decisions that affect their work and to perform their duties effectively.

As a result, it is thought that the adaptation of the digital leadership scale developed in Germany to Turkish can be an effective tool in evaluating the digital leadership skills of educational leaders. Therefore, it is hoped that the adapted digital leadership scale, which is a powerful tool that can be used to evaluate and develop the digital leadership skills of educational leaders, will make significant contributions to the literature. Future research may allow us to better understand and develop the digital leadership skills of educational leaders, as the effects of the scale on leaders at different educational levels are examined in more depth and the individual demonstrates both his/her self-organization skills, digital leadership, and the digital leadership development of his/her manager.

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**: İnönü University, E.383601.

Contribution of Authors

The authors contributed equally to all the stages of the study.

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APPENDIX

Dijital Leadership Scale (Turkish Version)

Aşağıdaki maddeler öğretmenlerin dijital liderlik özellikleri ve algılarını ortaya çıkarmak amacıyla hazırlanmıştır. Lütfen maddeleri görevli olduğunuz okulu dikkate alarak değerlendirip, uygun olan kutucuğa **X** işareti koyunuz.	**SIKLIK DERECESİ**				
	① Hiçbir Zaman	**② Nadiren**	**③ Bazen**	**④ Çoğu Zaman**	**⑤Her Zaman**
Dijital Liderlik Ölçeği					
1. İşimi ve dijital çalışma ortamımı etkileyen kararlara dahil edilirim.	①	②	③	④	⑤
2. Okul müdürüm dijital okuryazarlığımı geliştirmem için beni destekler.	①	②	③	④	⑤
3. Dijitalleşmeyle ilgili sorunlarım olduğunda okul müdürümden destek alırım.	①	②	③	④	⑤
4. Dijital çalışmalarımın niteliği hakkında düzenli olarak okul müdürümden geri bildirim alırım.	①	②	③	④	⑤
5. Okul müdürüm dijital işlerimi yapmak için ihtiyacım olan bilgilere ulaşmamı destekler.	①	②	③	④	⑤
6. Dijital uygulamaları daha iyi anlamam ve kullanmam konusunda okul müdürüm beni destekler.	①	②	③	④	⑤
7. Okul müdürüm, okulda dijital çalışma yöntemlerini teşvik eder.	①	②	③	④	⑤
8. Görevlerimi yerine getirmek için hangi çalışma yöntemlerini, süreçleri ve çözüm yaklaşımlarını kullanacağımı belirleyebilirim.	①	②	③	④	⑤
9. Meslektaşlarımla işbirliği içinde görevlerimi yerine getiririm.	①	②	③	④	⑤