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Adaptation of flexible thinking in learning scale to Turkish culture

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Highlights

- Flexible thinking in learning is one of the most important and relevant skills in our age. The aim of this study is to adapt the measurement tool developed by Barak and Levenberg (2016) to Turkish culture.
- Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to ensure the validity and reliability of the measurement tool adapted within the scope of the study.
- The scale can be used in a variety of settings, including educational settings such as e-learning, distance education, and emergency distance education. Additionally, the FTL scale has the potential to contribute to research on education in business settings.

Article Info: Research Article

Keywords: *Flexible Thinking, Technology Acceptance, Open-Mindedness, Scale Adaptation*

Abstract

This article aims to adapt the Flexible Thinking in Learning (FTL) scale developed by Barak and Levenberg in 2016 to Turkish culture The FTL scale, whose original language is English, consists of three sub-dimensions: “Acceptance of Learning Technologies”, “Open-Mindedness in Learning” and “Adaptation to New Learning Situations”. During the process, language and field experts conducted mutual translations between English and Turkish to assess the language equivalence of the scale. The original scale was supplied to English teachers to measure the degree of similarity between the original language (English version) and the translated language (Turkish version). After a fifteen-day interval, the same teachers were given the adapted version of the scale. The degree of similarity between the scale's original language and its Turkish translation was calculated. Once the scale’s harmony was deemed satisfactory in both languages, a pilot study was conducted to receive feedback and suggestions on the comprehensibility, applicability, and general structure of the scale. After necessary improvements were made, the scale was finalized. The Flexible Thinking in Learning (FTL) scale, which was adapted to Turkish, was applied to 516 volunteer teachers. As per the findings of the analysis, the adapted scale has three sub-dimensions, just like the original scale. The measured structure of the adapted scale was found to be consistent with the original scale’s factor structure.

1. Introduction

Technologies are one of the leading factors that change and transform the structure of societies. The exponential growth in technology in recent years has brought about a significant transformation in the knowledge and skill sets of individuals. This has piqued the interest of researchers who have examined the current state and explored solutions for improving them. In the 21st century, International Society for Technology in Education (ISTE), one of the world's top organizations devoted to the use of technology in education, has developed and established standards for both teachers and students. When the standards set for students and teachers are examined, the standards related to being a "learner," which rank first in both categories, emphasize the improvement of learning by using technology. According to ISTE standards, the

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teacher is first and foremost a "learner" or "student and to raise students with 21st century skills, instructors should also have these skills and develop 21st century skills. These skills may include computational thinking, problem solving, and flexible thinking. In this context, the aim of the study is to adapt the Flexible Thinking in Learning (FTL) scale, which was developed to measure the ability of flexible thinking in learning, which is considered important for our age, to Turkish culture.

1.1. Literature

The rise of communication and information technologies has led to a change in the demands of 21st century skills compared to those of the 20th century (Dede, 2010). However, regardless of the era, the skills that are necessary for people in any era are those that will enable them to survive. These skills are often aimed at teaching and learning rather than memorizing. They include high-level reasoning, deep understanding, complex thinking, and communication skills (Saavedra & Opfer, 2012).Beside these skills problem-solving and critical thinking skills have been considered essential to human development throughout history. Skills that were once considered innovative, like information literacy and global awareness, are now present in all communities (Boyacı & Atalay, 2016). Because people's needs for work and self-actualization in the 21st century are very different from those of the preceding century new skills has emerged. The Partnership for 21st Century (P21, 2019) has categorized these emerging skills under three main headings in its framework for 21st century skills:

- Learning and innovation
- Media, information, and technology
- Life and career skills

Learning and innovation skills comprise many different elements, including problem-solving, cooperation, critical thinking, creativity and innovation. Regarding media, information, and technology these are referred to as literacy such as technology literacy, media literacy and information literacy. However, life and career skills encompass productivity, communication, social and intercultural competence, accountability, flexibility and adaptation, leadership, and responsibility. Among these life and career skills adaptability and flexibility are prominent skills in 21st century learning. Osman and colleagues (2009) refer to adaptation as the capacity to use a variety of goals, tasks, and inputs while understanding and complying with limitations such as time, resources, and systems to better adjust to current or forthcoming circumstances. Flexibility can be considered independent, different behaviors such as multi-tasking, generating innovations, and flexible problem solving (Ionescu, 2012).

Flexible thinking has emerged as a critical skill for both students and instructors (Barak & Levenberg, 2016a). This is primarily due to the fact that flexible thinking skills include various key elements such as learning technologies acceptance, open-mindedness in learning, and adaptation to new learning situations. From an educational perspective, these skills are indispensable in the quest to acquire 21st century skills. In the 21st century, educational environments are differentiating every day with the integration of technology as a result online learning is becoming increasingly important and relevant today (Tugtekin, 2023). Therefore advanced information and communication technology (ICT), such as cloud applications and mobile devices, have special capabilities that can create new learning environments in online education. These capabilities allow students to gather and analyze data, generate information, solve problems, and communicate their results (Barak, 2018). When integrated into higher education courses, ICTs can help students develop digital literacy and self-efficacy, collaborative learning skills, conceptual understanding, and higher-order thinking skills. Beside these elements such as adapting to technology and novel learning systems and being open-minded in learning are important sub elements of flexible thinking which play important role in education.

ICT is known to be crucial for the educational process. ICTs are constantly developing and evolving, which is leading to the emergence of new learning and teaching methods. ICTs can facilitate higher education

through blended learning, which combines traditional face-to-face instruction with online learning, or through distance online learning, which allows students and instructors to learn and collaborate online. ICTs can be used to support a variety of instructional designs and learning environments, but they require instructors and students to be open to new ideas and willing to adapt to new ways of learning (Moore, Dickson-Deane, & Galyen, 2011). The adoption and integration of ICT in the teaching and learning process is therefore primarily the responsibility of teachers. (Baş, Kubiatko & Sünbül, 2016). Apart from this responsibility, several factors affect how well teachers will adopt technology in the classroom and how they will integrate it. According to Davis' (1989) among these factors technology adoption model perceived usefulness has the biggest impact on how teachers employ technology in their classes. (Scherer, Siddiq & Teo, 2015). Development in ICT may lead to improvement and novel ideas in learning and teaching methods in education.

In this study, we examined the studies using the Flexible Thinking in Learning (FTL) scale, and the target groups of these studies have focused on higher education students (i.e. Tseng, Kuo & Walsh, 2020; Yildiz Durak & Atman Uslu, 2023), but there are few studies on teachers who will provide these skills to students. Therefore, in the present study we focused on teachers. For this reason, the fact that the study was conducted with teachers was considered to be beneficial both in terms of the application of the FTL scale which was developed from the data collected from students and generally applied to students, to different populations and in terms of its use on different adult populations in future studies. In addition, applying the scale to different groups of teachers at one-year intervals and conducting exploratory factor analysis with one group and confirmatory factor analysis with another group makes the study more valuable.

2. Methodology

The objective of this study is to examine the reliability and validity of the FTL scale developed by Barak and Levenberg in 2016 by adapting it into Turkish. During the implementation phase of the Turkish-translated FTL scale, a general survey model was adopted, which is a quantitative research approach. As described by Karasar (2014, p. 77), survey models serve to depict a current or past situation as it exists.

2.1.Sampling

Study population consisted of teachers working in public schools across in Turkey. We shared the FTL survey on WhatsApp, Telegram, and Facebook groups that serve only to teachers. A total of 516 teachers who work in the Ministry of Education were included in this study.

2.2.Characteristics of the Original FTL Scale

The FTL scale, developed by Barak and Levenberg in 2016, consists of three sub-dimensions:

- Learning Technologies Acceptance (TA)
- Open-Mindedness in Learning (OM)
- Adaptation to New Learning Situations (AL)

Based on conducted studies, it was reported that the content, construct, discriminant, known-groups, stability across populations-time, and concurrent validity of the FTL scale were achieved (Barak & Levenberg, 2016). The item normalized regression weight estimations (measures) for the three-factor model FTL scale were as follows:

- TA items ranged from 0.719 to 0.881
- OM items ranged from 0.531 to 0.806
- AL items ranged from 0.610 to 0.795 ($p<0.001$)

All structure explained 60% of the total variance. The FTL scale is graded on a Likert scale of 1 to 6, with 6 representing the most favorable statements. 1: "Strongly Disagree," 2: "Disagree," 3: "Partially Disagree," 4: "Partially Agree," 5: "Agree," 6: "Strongly Agree".

Barak and Levenberg's (2016b) FTL scale consists of three subdimensions: TA, OM, and AL, and comprises 19 items. During the scale's development, principal component analysis (PCA) was used to conduct an exploratory factor analysis (EFA). Items with high factor loadings (>0.45) were selected after assessing the cross-loadings. The scale's initial structure consisted of 20 items, producing a three-factor structure using Kaiser normalization and varimax rotation techniques. All 19 items except for "I am open to learning in different ways" exhibited significant loadings on at least one factor. After removing the item that did not load on any of the three factors, it was removed from the scale structure, and the EFA was rerun with 19 items. It was found that the factors TA, OM, and AL explained 60.00% of the total variance. The scale's reported reliability coefficient is 0.91. The scale's sub-scales' reliability coefficients were 0.90, 0.84, and 0.83 for TA, OM, and AL, respectively. Means and standard deviations of the factors are presented in Table 1.

Table 1.

Means And Standard Deviations Of The Factors Of The Flexible Thinking in Learning Scale And The Component Correlation Matrix Values

Factors	M	SD	1	2	3
Factor 1: TA	4.41	0.98	-		
Factor 2: OM	4.76	0.69	0.50***	-	
Factor 3: AL	4.37	0.74	0.54***	0.55***	-

Note. TA: Learning technologies acceptance, OM: Open-mindedness in learning, AL: Adapting to new learning situations *** p<.001

2.3.Reliability Study

Cronbach's alpha coefficient was employed to determine the internal consistency of the pilot study and sample study data. IBM SPSS v22 was used to analyze the data. The sample's internal consistency coefficient was determined to be 0.915, and the pilot study's internal consistency coefficient was 0.956. According to Büyüköztürk (2014), an alpha value of 0.70 or higher is considered sufficient for internal consistency. Therefore, we can conclude that the data from the pilot and sample studies are both reliable.

2.4.Validity Study

The initial phase of adapting the FTL scale into Turkish involved the administration of mutual translations (English-Turkish and Turkish-English) to evaluate the scale's linguistic equivalence. A group of eight experts was tasked with translating the original English version into Turkish. The group consisted of four bilingual linguists and four domain experts who were proficient in both languages and fields. Two researchers independently reviewed the translations, leading to the development of two separate Turkish versions of the scale. Upon comparison of the expert translations, an 84% similarity rate was observed between the two researchers' outputs. The researchers compared the items together, and the scale items that were perceived differently by the researchers were reconsidered. Necessary corrections were made, and a Turkish draft form was created with a joint decision. The Turkish scale form created by the translator and field experts was translated back into its original language (English), by five different language experts. The researchers reviewed all the back-translations made by the language experts, and the English scale form was created again. The similarity between the original version of the scale and the English back translation was 90%. Based on these similarity rates, the researchers jointly concluded that there is no difference between the original English version of the scale and the Turkish translation version. To determine whether the Turkish form, which was created by translators and professionals, has the same meaning as the original English form, we administered first the Turkish translation and then the original English form online at two-week intervals to 41 English teachers who work in public schools and are fluent in both languages. We then compared the two scales' results. The Pearson product-moment coefficient

between the two surveys' results was 0.704. To assess the comprehensibility of the form, a pilot study was conducted with a representative group of 117 volunteer teachers, mirroring the intended population for which the scale was designed.

The researchers analyzed the feedback and recommendations provided by the participating volunteer teachers with respect to the overall structure, comprehensibility, readability, and applicability of the scale. Based on the feedback, requisite modifications were made to the Turkish version of the FTL scale, culminating in its final form. It is significant to highlight that teachers who had taken part in the pilot study were excluded from the research sample. Figure 2 provides a graphic representation of the research process.

3. Findings

Following the pilot study conducted as part of the adaptation study, the first application of the FTL scale was conducted between April 18 and 23, 2021, with the participation of 309 teachers. Exploratory factor analysis (EFA) was conducted on data from 300 participants using SPSS v22 software. The second application of the scale took place between September 7 and 30, 2022, and confirmatory factor analysis (CFA) was conducted using Lisrel software to confirm the factor structure of data collected from 216 teachers. This section of the study presents the results of the EFA and CFA.

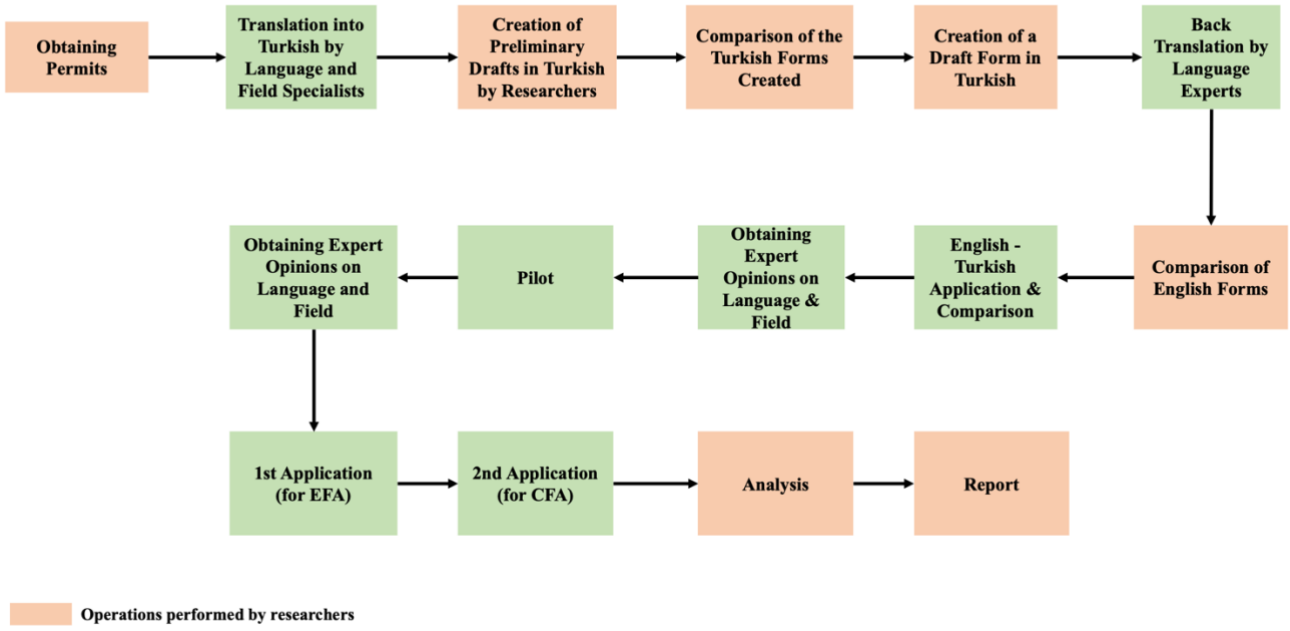

Fig. 2. Steps of Research Process

3.1.1. Exploratory Factor Analysis of the FTL Scale

The suitability of the data gathered from 300 participants for factor analysis was evaluated using the Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's test of sphericity. Bartlett's test evaluates the presence of variable associations based on partial correlations, while the KMO coefficient indicates the suitability of factor extraction. The KMO coefficient should be greater than 0.70, and a significant Bartlett's test that the scores are normally distributed ($p < .05$) (Büyüköztürk, 2014).

Table 2.

Adaptation Study of Flexible Thinking in Learning Scale Application Data Factor Analysis Conformity Test

KMO Sampling Adequacy		.902
Barlett's test	Chi-SquareValue	3373.353
	SD	171
	p	.000

For the data gathered for the adaptation study, the Kaiser-Meyer-Olkin (KMO) coefficient was 0.902, indicating a good fit for factor analysis. Bartlett's test was also significant ($p < .05$), showing that the data had a normal distribution. Principle component analysis (PCA) with Kaiser normalization and oblimin rotation technique were used for factor analysis, revealing that the factors TA, OM, and AL explained 61.73% of the total variance. The scale's internal reliability score was 0.91, with sub-scales of 0.86 for TA, 0.84 for OM, and 0.90 for AL. Table 3 displays the means, standard deviations, and component correlation matrix values.

Table 3.

Mean, Standard Deviation and Component Correlation Matrix of Flexible Thinking in Learning Scale Subscales

Factor	**M**	**SD**	**1**	**2**	**3**
Factor1: TA	4.97	.68	-		
Factor2: OM	5.21	.50	0.36***	-	
Factor3: AL	4.97	.55	0.56***	0.22***	-

Note. TA: Learning technologies acceptance, OM: Open-mindedness in learning, AL: Adapting to new learning situations *** p<.001

Table 4.

Eigenvalues and Stacked Variances of Flexible Thinking in Learning Scale Factors

Dimension	**Eigen value**	**Variance**	**Stacked Variance**
1. Factor	7.798	41.044	41.044
2. Factor	2.656	13.978	55.022
3. Factor	1.275	6.711	61.733

Table 4 shows the eigenvalues, explained variances, and cumulative variances of the FTL scale factors. The three factors accounted for 61.73% of the total variance, which is deemed satisfactory by Büyüköztürk (2014). Also Büyüköztürk (2014), posits that the explained total variance in multifactorial structures should exceed 30%.

Table 5.

Item Factor Loading Values of the FTL Scale Table

Item	Factor 1	Factor 2	Factor 3
Item 2	.859		
Item 5	.822		
Item 4	.795		
Item 1	.714		
Item 3	.698		
Item 7		.828	
Item 8		.816	
Item 6		.797	
Item 12		.631	
Item 9		.623	
Item 10		.519	
Item 11		.416	
Item 18			.829
Item 13			.792
Item 14			.784
Item 15			.776
Item 6			.770
Item 17			.670
Item 19			.474

The factor loadings for the items making up the FTL scale are shown in Table 5.

- TA factor (Factor 1) comprises 5 items: I2, I5, I4, I1, and I3. The factor loadings for these items range from .859 to .698.
- OM factor (Factor 2) includes 7 items: I7, I8, I6, I12, I9, I11, and I10. The factor loadings for these items range from .828 to .416.

AL factor (Factor 3) consists of 7 items: I8, I13, I14, I15, I16, I17, and I19. The factor loadings for these items range from .829 to .474.

Table 6.

Total, Item, and Item Discrimination Index Values of the FTL Scale

Item	Item total correlation	Item Remainder (Reliability coefficient score)	Item Discrimination t (Lower%27 – Upper%27)	*p*
Item 1	.635	.909	13.243	.000
Item 2	.512	.913	8.894	.000
Item 3	.587	.910	11.177	.000
Item 4	.623	.909	12.234	.000
Item 5	.605	.910	11.085	.000
Item 6	.375	.915	8.212	.000
Item 7	.487	.913	11.397	.000
Item 8	.436	.914	9.667	.000
Item 9	.544	.911	13.224	.000
Item 10	.555	.911	10.869	.000
Item 11	.535	.911	10.643	.000
Item 12	.383	.915	9.667	.000
Item 13	.634	.909	13.481	.000
Item 14	.696	.907	14.418	.000
Item 15	.692	.907	14.434	.000
Item 16	.724	.907	15.894	.000
Item 17	.601	.910	12.129	.000
Item 18	.680	.908	13.556	.000
Item 19	.691	.908	14.780	.000

Table 6 presents the item total score, item remainder, and item discrimination index values of the FTL Scale. The correlation analysis indicates that most items (except for item 16) have a moderate correlation with the total scale. Furthermore, all items have significant discriminative power ($p < .001$). Therefore, it can be concluded that the scale items are reliable and consistent with the scale.

Table 7.

FTL Scale and Its Correlation with Subdimensions

Factors	**r**	***p***
FTL Scale & Factor 1	.802	.000
FTL Scale & Factor 2	.742	.000
FTL Scale & Factor 3	.893	.000
Factor 1& Factor 2	.320	.000
Factor 1 & Factor 3	.655	.000
Factor 2 & Factor 3	.742	.000

Table 7 shows the correlation coefficients among the FTL scale and its sub-scales. The results indicate a moderate positive association between the first factor and the second factor, as well as between the first factor and the third factor. Moreover, a significant positive association was seen between the FTL scale and the first, second, and third factors.

3.1.2. Confirmatory Factor Analysis of the FTL Scale

To confirm the factor structure of the FTL scale, confirmatory factor analysis (CFA) was carried out in this study using the Lisrel software. The fit of the model to the data was assessed using commonly used statistics, including Chi-square ($\chi 2$), $\chi 2$/sd, RMSEA, RMR, GFI, and AGFI. A range of fit indices were used to determine the adequacy of the model fit, with excellent fit being indicated by a $\chi 2$/df ratio of less than 3, NFI, NNFI, IFI, and RFI values of .95 and above, CFI values of .97 and above, GFI and AGFI values of 0.90 and above, and RMR and RMSEA values between .000 and 0.050. Acceptable fit was indicated by NFI, NNF, IFI, and RFI values of .90 and above, CFI of .95 and above, GFI and AFGI values of .85 and above, and RMR and RMSEA values between .050 and .080 (Tabachnick et al., 2013). The collected data had a $\chi 2$/df ratio of 2.40, NFI=.96, NNFI=.97, CFI=.98, IFI=.98, RFI=.95, GFI=.90, AGFI=.86, RMR=.035 and RMSE=.068, indicating excellent fit of the adopted FTL scale. The model is presented in Figure-3, and the order of items within each factor was modified as follows: Factor1 (TA): I2, I1, I3, I5, I4; Factor2 (OM): I6, I8, I7, I2, I11, I10, I9; Factor3 (AL): I17, I16, I14, I15, I18, I19, I13.

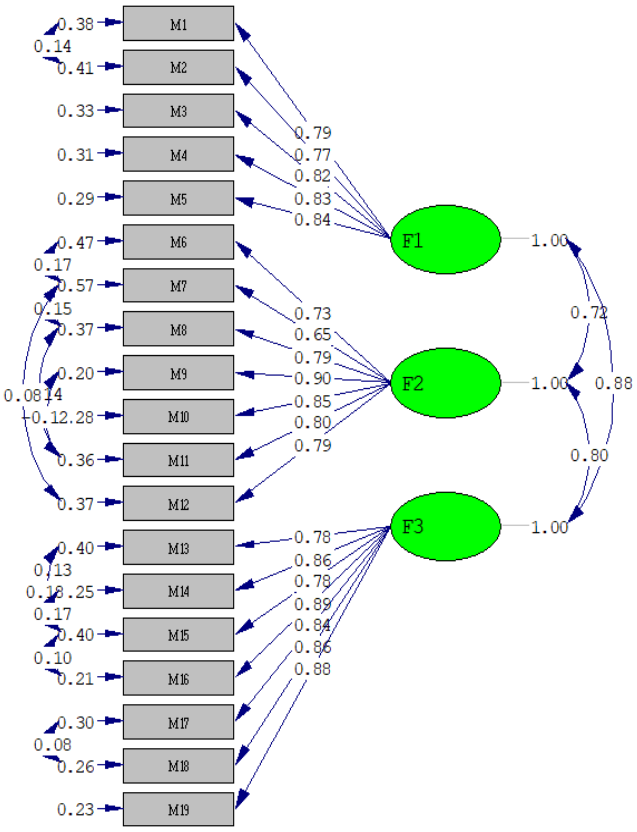

Fig. 3. CFA Modification Model fo the FTL Scale

4. Conclusion and Suggestions

This research aimed to culturally adapt the FTL scale, which consists of three sub-dimensions: TA, OM, and AL, with 19 items. Three factors explained 60.0% of the total variance in the initial analysis. However, in our study, these three factors accounted for 61.73% of all variances. The original scale's Cronbach's alpha reliability coefficient was 0.91 and Tseng, Kuo & Walsh (2020) found the alpha value to be 0.96, which was consistent with the results of the current investigation (0.92). Additionally, in the original sub-scales of TA, OM, and AL all had reliability coefficients of 0.90, 0.84, and 0.83, respectively. For the sub-scales, values of 0.86, 0.84, and 0.90 were obtained respectively in the Turkish form. The results of the Exploratory Factor Analysis (EFA) demonstrated that the assessment tool had been successfully adapted.

Structural Equation Modeling (SEM) was used to test the theoretical model and validate the factor structure during the development of the original FTL scale. The item standardized regression weight estimates for the three-factor model of the FTL scale ranged between the following values: TA 0.719 to 0.884; OM 0.531 to 0.806; and AL 0.610 to 0.795. The three-factor model fit the empirical data, $\chi 2$ (130, N=429) = 267. 7, p = 0.000; Goodness of Fit Index [GFI] = 0.94; Tucker Lewis Index [TLI] = 0.96; Comparative Fit Index [CFI] = 0.97; and Root-Mean-Square Error of Approximation [RMSEA] = 0.05 (Barak & Levenberg, 2016b). Additionally, Tseng, Kuo & Walsh (2020) conducted a Confirmatory Factor Analysis (CFA) and reported $\chi 2$ (101, N = 254) = 259.34, TLI = 0.947, RMSEA = 0.079, GFI = 0.90, CFI = 0.956. In this study, CFA was used to confirm the construct's three-factor model structure of Turkish form of FTL scale. The obtained results can be listed as follows: $\chi 2/df$ =2.40, NFI=0.96, NNFI=0.97, CFI =.98, IFI=0.98, RFI=0.95, GFI=0.90, AGFI=0.86, RMR=0.035, and RMSE=0.068. According to CFA results, we performed an excellent adaptation process.

In conclusion, our study and analyzes show that successfully adapted and validated the FTL scale to Turkish language and culture. We found that the scale is a reliable and valid instrument for measuring flexible thinking in learning. The scale can be used in various fields, particularly in educational sciences, such as e-learning, distance education, and emergency distance education. Furthermore, the FTL scale has the

potential to contribute to research on education in business contexts. In addition to all these, it is recommended that it be implemented on a sample of university students and adults, with priority given to teachers. Overall, the Turkish version of the FTL scale is a valuable tool for assessing and promoting flexible thinking in learning.

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Appendix

Turkish version of the FTL scale

Boyutlar	No	Maddeler	1	2	3	4	5	6
Öğrenme Teknolojilerinin Kabulü	1	Yazılım güncellemleri gibi teknlojik değişikliklere kolaylıkla uyum sağlarım						
	2	Yeni öğrenme teknolojilerine hızlıca uyum sağlarım						
	3	Öğrenmeme yardımcı olabilecek yeni teknolojik araçlardaki güncellemelere açığım						
	4	Öğrenme için çeşitli teknolojik araçları kullanırım ve onlar arasında sıklıkla geçiş yaparım						
	5	Yeni öğrenme teknolojilerini deneyimlemeyi severim						
Öğrenmede Açık fikirlilik	6	Öğrenme sürecinde, farklı bakış açılarının ifade edilmesi önemlidir						
	7	Öğrenirken, çeşitli olasılıkları dikkate alma eğilimindeyim						
	8	Öğrenirken, benim fikriml ie çelişse bile çeşitli fikirleri dinlerim						
	9	Derin öğrenme için, çeşitli bakış açılarını inceleme eğilimindeyim						
	10	Öğrenirken, olguları farklı açılarından gözlemlerim						
	11	Öğrenme sürecinde, geri bildirim ve eleştiriye açığım						
	12	Haklı olduğuma emin olsam bile diğer öğrenenlerin fikirlerini dinlerim						
Yeni Öğrenme Durumlarına Uyum Sağlama	13	Yeni öğrenme durumuna alışmakta sorun yaşamam						
	14	Farklı öğrenme durumlarına uyum sağlarım						
	15	Kendimi öğrenme koşullarındaki değişikliklere zorlanmaksızın uydururum						
	16	Öğrenme yolları değiştiğinde, kolaylıkla uyum sağlarım						
	17	Herhangi bir öğrenme durumunda koşullara uyum sağlarım						
	18	Çaba ve çalışma gerektirse bile öğrenme yollarımdaki değişikliklere açığım						
	19	Öğrenmede yeni deneyimlere açığım						