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DIGITAL LITERACY AS WHOLE OF DIGITAL COMPETENCES: SCALE DEVELOPMENT STUDY[*]

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Abstract

The purpose of the study is to develop a valid and reliable Digital Literacy Scale (DLS) which will reveal the digital literacy of university students and graduates. Because it is assumed that this sample group uses information technologies much more intensively. The process of developing this scale included many stages. First, item pool (a total of 54 items) was created by reviewing the relevant literature, and the view of 11 experts were taken with four-point rating. Afterwards, the content validity index related to scale and its items was calculated. In the first phase of the study, exploratory factor analysis was performed that was applied to 451 participants for construct validity. Afterwards, the main study was conducted with a group of 1287 participants and confirmatory factor analysis was performed. Digital Literacy Scale's reliability and validity was tested and approved. It was developed as 29-item scale including six factors. In this study, score ranges that represent the digital literacy levels of university students and graduates (low, below medium, medium, above medium and high) are introduced by converting them to Z standard score and the competencies that can be reached for each level are depicted.

Keywords: Digital Literacy, Digital Competence, Scale Development, Digital Literacy Scale, Validity and Reliability

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DİJİTAL YETKİNLİKLER BÜTÜNÜ OLARAK DİJİTAL OKURYAZARLIK: ÖLÇEK GELİŞTİRME ÇALIŞMASI

Özet

Bu çalışmanın amacı üniversite öğrencilerinin ve mezunlarının dijital okuryazarlıklarını ortaya çıkaracak geçerli ve güvenilir bir Dijital Okuryazarlık Ölçeği (DOYÖ) geliştirmektir. Ölçek geliştirme süreci çeşitli adımları kapsamaktadır. Öncelikle ilgili literatür taraması yapılarak 54 maddelik bir madde havuzu oluşturulmuştur. Bu madde havuzu 11 uzman tarafından dörtlü derecelendirme ile değerlendirilmiştir. Uzman görüşü neticesinde elde edilen verilerle ölçek ve maddelere ilişkin kapsam geçerlilik indeksleri hesaplanmıştır. Araştırmanın ilk aşamasında yapı geçerliliği için 451 kişiyle pilot çalışma uygulanmış ve ilgili madde analizleri yapılarak keşfedici faktör analizi yapılmıştır. Ardından 1287 kişilik katılımcı grubuyla ana uygulama ve doğrulayıcı faktör analizi yapılmıştır. Ölçeğin güvenilirlik ve geçerlilik sonuçları test edilmiş ve onaylanmıştır. Dijital Okuryazarlık Ölçeği, 29 maddelik ve 6 faktörlü bir ölçek olarak geliştirilmiştir. Ayrıca bu çalışmada üniversite öğrencilerinin ve mezunlarının dijital okuryazarlık düzeylerini (düşük, orta altı, orta, orta üstü ve yüksek) temsil eden puan aralıkları Z standart puana dönüştürülerek ortaya konmuş ve her düzeye ilişkin ulaşılabilecek yetkinlikler betimlemiştir.

Anahtar Kelimeler: Dijital Okuryazarlık, Dijital Yetkinlik, Ölçek Geliştirme, Dijital Okuryazarlık Ölçeği, Geçerlik ve Güvenirlik

Introduction

In today's world, digital literacy is crucial in order to achieve more participation into the society, employment and keeping up with technological developments. Digital literacy, which is related to many of the cognitive fields, should be considered as one of the main determinants of the digital transformation that people in 21st century have to adapt. Main reasons of this adaption are keeping up with the requirements of our era, keeping up with the flow of life and recognizing the unpredictable and uncontrollable possible threats of transformation and being prepared for them. In addition to keeping up with the era individually, digital literacy is also of great importance in terms of creating innovative and practical education curricula suitable for digital age, their sustainability, access to digital learning, lifelong learning activities and development of these activities.

Expressing digital literacy by means of teachable and measurable materials is critical for the applications to be made and the steps to be taken. In this manner, there is a need for

tools that can measure which competencies can be expressed in digital literacy. These competencies are related to digital participation, online learning, adaptation to the digital age, social reconstruction supported by digital technologies and the ability to manage the risks of the digital age. Therefore, researchers, legislators, and international institutions such as the EU and OECD are working on measuring digital literacy. These measurements generally provide opportunity and convenience in order to;

- reveal the digital competencies required to increase employment, development, and productivity,
- evaluate the activities that are done or planned for individuals in society to adapt more effectively to the digital age,
- design education policies to meet the social and economic needs of the digital age,
- appraise the digital literacy of all citizens, especially educators and students, and determining the strengths and weaknesses of the society in the digital field, and planning and implementing accordingly,
- create the awareness and precaution studies against threats and dangers caused by digital technologies,
- create digital action plans and to use resources more effectively by governments.

In Turkey, as well as in the world, there is an increasing importance given to the digital literacy in both public, academic institutions and the private sector. A number of scales are developed in order to measure the digital literacy level of students and citizens. Kıyıcı (2008) developed a scale for evaluate the numerical literacy of teacher candidates. Acar (2015) created a scale in order to assest digital literacy of parents and their children. Another scale developed by Öçal (2017) for measuring of digital literacy of primary school teachers. The most applied scale in Turkey is belong to Ng (2012) as "digital literacy scale." It adapted by Güngören, Uyanık & Erdoğan (2017) to Turkish. In the literature review, the problems related to measuring the digital literacy level can be observed. The observation of these deficiencies constitutes the problem of this research. The problems leading to the design of this research and the evaluations for the solutions can be sorted as: Firstly, the current scales should be updated on account of the continuous development of digital technologies. For instance, some actions which depend on old technologies such as using the floppy disk in order to transfer a data or listening to music

from the VCD are considered as obsolete digital competencies. These sort of simple skills cannot be considered as dijital literacy but first step of digital competence (Martin, 2008). Secondly, in the Turkish literature, the existing scales are generally limited to education faculties (Kıyıcı, 2008, Öçal, 2017) so it can be seen as that there is a need for a comprehensive scale. In today's world, although, digital literacy is crucial for many disciplines, it has been determined that the samples are not taken largely in the studies in Turkey. In the literature reviewing studies, a comprehensive scale that is able to compare students from different undergraduate programs of the universities and different age groups (ranging from 20s to 50s) does not exist in the studies conducted in Turkey. Thirdly, for today's university students and graduates, actions such as sending e-mails and downloading files are now simple to represent digital literacy, in fact these competencies are a precondition for digital literacy in general. Assuming university students and graduates as the target community, there is a need for a scale that unveils their digital literacy. Considering such deficiencies and needs in the field of media and education, it is aimed to develop a comprehensive digital literacy scale that is up-to-date, reliable and valid to represent the digital competencies of university students and graduates, includes different demographic features and topics such as cloud computing.

Digital Literacy Scale consists of 29 items and have 6 dimensions (Ethics and Responsibility, General Information and Functional Skills, Daily Use, Advanced Production, Privacy and Security, Social Dimension). Confirmatory factor analysis was applied with the main application and it was concluded that all values of the structural validity of the scale model were at acceptable levels. Thus, the reliability validity of Digital Literacy Scale has been tested and approved.

1. Literature Review

The term of digital literacy was first introduced to literature by Gilster (1997, p.1) in the late 1990s (Spante, Hashemi, Lundin, & Alger, 2018). Gilster explains the term in his book as:

> Digital Literacy is the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers (1997, p. 2).

Gilster's definition focuses on cognition, one of the key elements of digital literacy. With regard to this definition which emphasizes cognition, by making the analogy of traditional literacy that is adapted to digital environments, Bawden (2001, p.23) stated that Gilster's definition was incomplete and he associated digital literacy not only with reading, writing or interpreting information in digital environments, but also with how technological devices work and awareness of technology. Gourlay, Hamilton and Lea (2013, p.7) and Hall, Nix and Baker (2013, p.223) stated in their studies that digital literacy expresses the similar meaning with the concept of "*know-how"* and they described digital literacy as functional use of technology. Kinzer (2010, p.52) defined the digital literacy as communicating via technologic devices, cooperation, finding information, and the ability to critically evaluate. Especially, in today's world "know-how" knowledge and "critical thinking" are among the popular concepts that have gained even more significance.

According to Inoue, Naito and Koshizuka (1997, p.406) in order to perform more effectively in digital environments, individuals have to own not only digital abilities but also a number of cognitive, sociological, and emotional skills. For example, the capability of evaluation, understanding of features of information society, have knowledge about effects of it over society, recognition of the importance of information, basic operation skills of computers, information creation, organization and selection of information.

Digital literacy is the literacy type that includes these requirements and it is also an umbrella term for media literacy, information literacy and computer literacy. According to Goodfellow (2011, p.133), digital literacy is ability of awareness, behavior, and using digital technologies. According to Buckingham (2010, p.60), the concept of digital literacy is the least level of technical skills that users must have in order to use technology effectively and perform their basic duties. However, Burton, Summers, Lawrence and Noble (2015, p.2) emphasized the insufficiency of this definition in our era and, they also underlined that the meaning of digital literacy is much broader than minimal technical skills.

Eshet-Alkalai (2004, p.93) expressed digital literacy as survival skill in digital age. He emphasizes that digital literacy is important for the academic institutions and the private sector to communicate more effectively and that digital literacy is needed to

measure the quality of learning activities and studies conducted in online environments. Also, he points out that digital literacy is needed to design user friendly learning platforms. According to Bayrakcı (2020, p.20-21) digital literacy is "the whole of digital competencies" and includes:

- to use digital technologies in many areas from learning to problem solving, from entertainment to communication, from citizenship practices to private space, in a convenient, safe, and effective manner,
- to produce and collaborate with digital technologies,
- to evaluate the digital technologies and process,
- to develop awareness and critical perspective about digital technologies,
- to develop cognitive, social, and technical competencies about digital technologies.

2. Method and Survey Profile

The aim of this study is to develop a valid scale for measuring the digital literacy of undergraduate students and graduates. As a research method, cross-sectional design has been selected to achieve the purpose of the study. The cross-sectional survey method provides the opportunity to define the situation of the population of the research at any time by performing the data collection process over the sample at once. (Fraenkel & Wallen, 2011, p. 394)

This scale development work has two phases. SurveyMonkey is used to gather data of the undergraduate students and graduates which are sampled random in both pilot and main study.[1]

The sample Pilot study was carried out with 451 participants and main study was carried out with 1287 participants, in total it was applied to 1738 people. According to Yazıcıoğlu and Erdoğan (2004) sample size must be at least 1067 for to research more then 10 million universes. Because of this reason 1738 person included to research. Undergraduate students and graduates, from Turkey's seven different geographic area were reached using the online survey technique. Because it is assumed that this sample

[1] The data in this study were collected in October-December, 2019. Thus application for ethics approval didn't require for the study before 2020.

group uses information technologies much more intensively. Digital Literacy Scale can be applied to different demographic groups if the reliability and validity of scale will be tested and approved. The age range of the participants ranged from 17 to 76. Participants in pilot study consist of 236 males (52,3%) and 215 females (47,6%), 247 undergraduate students (54,7%), 204 graduates (45,3%). Exploratory factor analysis and item analysis were carried out based on the pilot study results. Participants in the main study consist of 688 females (53,5%) and a599 males (46,5%. Out of total 1287 participants, 689 undergraduate students (53,5%) and 564 graduates (43,8%) involve in the study.

3. Scale Development Process

The identification of digital literacy was accomplished based on qualitative exploration of digital literacy concepts and outcomes. In the first stage of scale development, the literature was reviewed and the studies on digital literacy were examined in order to understand digital literacy construct and its dimensions. The search was mainly made with the terms of "digital literacy / competence" and "numerical literacy", because these concepts are used interchangeably in the literature. Basic studies conducted in the international literature were also examined and items to be used in the scale were created. While creating the item pool, the main relevant works have been used including the research of Gilster (1997), Inoue, Naito and Koshizuka (1997), Eshet-Alkalai (2004), Hague & Payton (2010), Hobbs (2010), Martin (2009), Ng (2012), Yumyum (2018) and Öçal (2017). These resources were used to determine the characteristics, boundaries and structure, we want to measure, of digital literacy. And also these were used to create the conceptual structure of the digital literacy and to determine which competences can be attributed as in the content of digital literacy.

After examining the relevant studies, this study discussed potential items and their verb structures. A pool of 54 items which could represent the digital literacy was created by including the phrases that attract attention and frequently expressed in the previous scales and studies. Items were reviewed and corrected by two linguists for various criteria such as spelling error, simplicity, spelling rules, clarity, and suitability to academic language before expert view. Expert views were consulted to determine whether the 54-item draft was appropriate or not. The scale draft was evaluated by a total of 11 experts,

including seven academic researchers who have knowledge and / or studies in the field of digital literacy, two experts from the field of computer and instructional technology education, one expert from the field of measurement and evaluation, and one manager in the field of communication technologies. Within the scope of the study, the experts who were easily accessible and volunteered for the study were included in the study. Four-point rating was used in order to measure the consensus based on expert opinions.

3. 1. Determining the Content Validity Index

Content validity explains to what extent each scale item represents the competence, attitude, and skill that is aimed to be measured (Cronbach & Meehl, 1955). In order to evaluate the content validity of a measurement tool, it is necessary to obtain expert opinions regarding the representation power of the coverage area of each item and also the representation power of all items (Lawshe, 1975; Allen and Yen, 2002). The content validity and face validity of the items were determined by taking expert opinion and calculating the content validity index the relevance of each item to the whole structure was determined, and some items were corrected / removed. When the field-based studies are examined in the calculation of the content validity index, it is seen that different practices are used. In this study, Davis Method (1992) was preferred and 11 experts stated their opinions for each item 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant*)*. According to Davis Method, the content validity index for each item was computed as the number of experts giving a rating of either 3 or 4, divided by the number of experts. That is the proportion in agreement about relevance. It is accepted that items with a value less than 0.80 should be removed.

- CVI_i was used for content validity index for *each item* on a scale,
- CVI_s was used for content validity index for *the overall scale.*

The content validity coefficient for the whole scale was calculated as CVI_s=0,95. Items 4 and 22 were excluded from the scale with the lowest content validity index CVI_i= 0,72<0,80. It is seen that the content validity of the scale is quite high. In the scale, there is no reverse scored item, two items are removed and two item are revised. The form with 52-item was created and a pilot study was applied to a total of 451 undergraduate students and graduates, using the 5-point Likert scale *(Strongly Agree (5), Agree (4), Undecided (3), Disagree (2), Strongly Disagree (1))*.

3. 2. Analysis of Data

While creating the item pool, items planned to be under the same factor in theory were not given together, and the items were given in random order in the pilot questionnaire form. In the pilot study, in order to avoid the answers of distracted participants, a check item was added “Computer viruses are useful. (yes / no)” and as a result, the answers of 18 participants who said “yes” to this item were deleted. The proportion of deleted values is between 2-3%. As a result, the data were analyzed with the answers from 451 participants in the pilot study and the exploratory factor analysis was conducted. Then, the main application was applied to 1287 people and a confirmatory factor analysis was conducted.

It was concluded that the data, obtained as a result of descriptive, statistical hypothesis tests and graphical analysis showed normal distribution. In order to test the linearity assumption, the scatter plot is examined and it is seen that the points are clustered around the zero line.

The conjecture of singularity was checked by looking at the relationship between expressions. A plurality relationship between expressions indicates whether a variant is similar enough to replace another variant, expressing the same meaning. Singularity means that the correlation coefficient is 1.00. As a result of the analysis, it was observed that there were no variants with a relationship value of 0.80 or more with another variant or on the contrary with zero relation to each other. Finally, in order to check whether the available data and sample size would give reliable results for factor analysis, Kaiser-Meyer-Olkin's and Barlett's test of sphericity's results were evaluated. KMO and Bartlett Sphericity test results of Digital Literacy Scale draft is given in Table 1.

Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0,922
Bartlett's Test of Sphericity	Approx. Chi-Square	6674,083
	df	1326
	Sig.	0

The KMO sampling adequacy tests the size of the sample for its suitability for factor analysis. KMO can take values ranging from 0 to 1 and KMO values above 0.5 are considered suitable for factor analysis. At the same time; KMO values between 0.5 and 0.7 are considered to be average, values between 0.7 and 0.8 are good, values between 0.8 and 0.9 are very good and values above 0.9 are considered perfect (Field, 2009, p.647). The KMO sample adequacy value of this study is 0.92. This value shows that the available data are excellent for factor analysis. Bartlett's test of sphericity tests the homogeneity of factors and consistency of items / variants. The significance of the Bartlett value (p=0<0,005) indicates that the data is suitable for factor analysis (Yurdugül, 2005; Büyüköztürk Ş., 2002).

3. 3. Exploratory Factor Analysis and Factor Naming

After testing the suitability of the data for factor analysis, the factor extraction method is selected for revealing the construct validity of digital literacy. There are various techniques that are used to determine factors. The most common of these is the principal component analysis technique (Kleinbaum, Kupper, & Muller, 1988; Büyüköztürk Ş., 2002). This analysis calculates on the total variance, considering the relationship values of the variants. Thus, it takes into account the inherent and unexplained error variance of the data set and the unique variance of each item (Tabachnick and Fidell, 2013; Büyüköztürk, 2002). For this reason, principal component analysis is preferred in factor analysis. It has been subjected to the rotation process in order for the items to meet the other items with which they are most related and to be easier to interpret. When the correlation matrix between the factors in factor extraction are examined, the oblique rotation technique is preferred due to the values greater than 0.30. No limitation is made by the researcher in terms of the number of factors. The factor structure and factor load values obtained as a result of the exploratory factor analysis of Digital Literacy Scale are shown in Table 2.

Table 2. Factor Analysis

Item	Factors					
	F1	F2	F3	F4	F5	F6
I am aware that my personal or legal rights (privacy, copyright, freedom of speech, etc.) continue in digital media as well as in daily life.	0,8					
I know how to behave to protect myself and others' personal data (photo, address, family information, etc.) online	0,752					
I can inquire from different sources whether the information I accessed online is correct or not.	0,743					
I am aware of the ethical and legal responsibilities of behaviors such as cyberbullying (insult, swearing, hate speech, etc.) and online abusing.	0,735					
I can recognize digital games and content that are suitable for cognitive and moral development.	0,598					
I am aware that everything I do online is recorded.	0,559					
I am aware of the ethical and legal responsibilities that may arise from copyright violations in digital environments.	0,354					
I know what the concepts of licensed software, demo software, pirated software, malware, and crack are.		0,835				
I know what hardware and software technologies are.		0,781				
I can install / format the operating system on my computer.		0,769		0,304		
I can install software or programs on my computer or other electronic devices		0,767				
I know what Torent, Internet, World Wide Web (WWW) expressions mean.		0,691		-0,356		
I can change the proxy / dns settings of devices to access banned websites.		0,619				
I can effectively use e-Government applications (MHRS, UYAP, tax & penalty inquiry etc.)			0,728			
I can use cloud computing technologies (Google Drive, iCloud, Dropbox, etc.) effectively in daily life.			0,678			
I can use the calendar on mobile devices not only just for looking at date but also as reminder, for taking notes			0,66			
I can do activities such as "uploading videos / broadcasting" online.			0,654			

I can use digital technologies effectively in daily practice such as reservation, shopping, address finding etc.	0,65			
I can add a web page that i use to bookmarks or favorites.	0,555			
I can develop software / applications based on digital technologies.		0,801		
I can use at least one of the programming languages (Java, C, Visual Basic, PHP, etc.).		0,769		
I know how to restrict apps' access to my personal information (location, contacts, camera, etc.).			-0,815	
I can recognize and block unwanted / spam emails and phishing messages.			-0,728	
I can change the privacy / security settings on my social media posts and profile.			-0,648	
I am aware of how to create a strong password.			-0,615	
I can design and publish a website using web design systems (Weebly, WordPress, etc.).				-0,749
I can write and share on my own blog page or on different blogs.				-0,699
With the help of digital technologies, I can change various images (photography, sound recording and video, etc.) and produce new content.				-0,584
I can effectively use at least one software related to my field (Photoshop, SPSS, Premiere, Office Word, etc.).	0,357			-0,511
Subtraction Method: Principal Component Analysis. Transformation Method: Kaiser Oblimin[a] a. 9 unifications for transformation.				

As a result of the exploratory factor analysis, 52 items related to digital literacy structure are categorized in eleven factors with an eigenvalue higher than 1. These 11 factors explain 65.7% of the total variance of the structure. It is seen that values above 40% of total variance are acceptable in social sciences (Çokluk, Şekercioğlu, & Büyüköztürk, 2018; Akbulut, 2010). Item load values are between 0.30-0.78. The factor load value obtained as a result of the factor analysis is the critical value used for whether an item is included in any sub-dimension and it is the coefficient showing the strength of the relationship of the item with the factor in question. Çokluk, Şekercioğlu, and

Büyüköztürk (2018) state that if the load value of an item is above 0.30, it is at a significantly acceptable level. In this study, the factor load's lower cut-off point was determined as 0.30, and the factor analysis was carried out and the load value was sorted in ascending order, considering the values above it as significant. As a result of factor analysis, it is possible for an item to be under more than one factor. Considering this situation, it is suggested that the gap between factor loads of the measure should be at least 0.10 that can be taken in one factor (Tavşancıl, 2010). The load values in two factors, items with less than this critical value were excluded from the scale by considering them as overlapping items.

The factor analysis was repeated a number of times in different combinations by removing the items that are overlapping one by one with a factor load value below 0.30, and as a result, a 6-factor with 29 items with an eigenvalue greater than 1 included in digital literacy structure on the scale. The scree plot generated as a result of exploratory factor analysis regarding the factor structure of 29 items is given below.

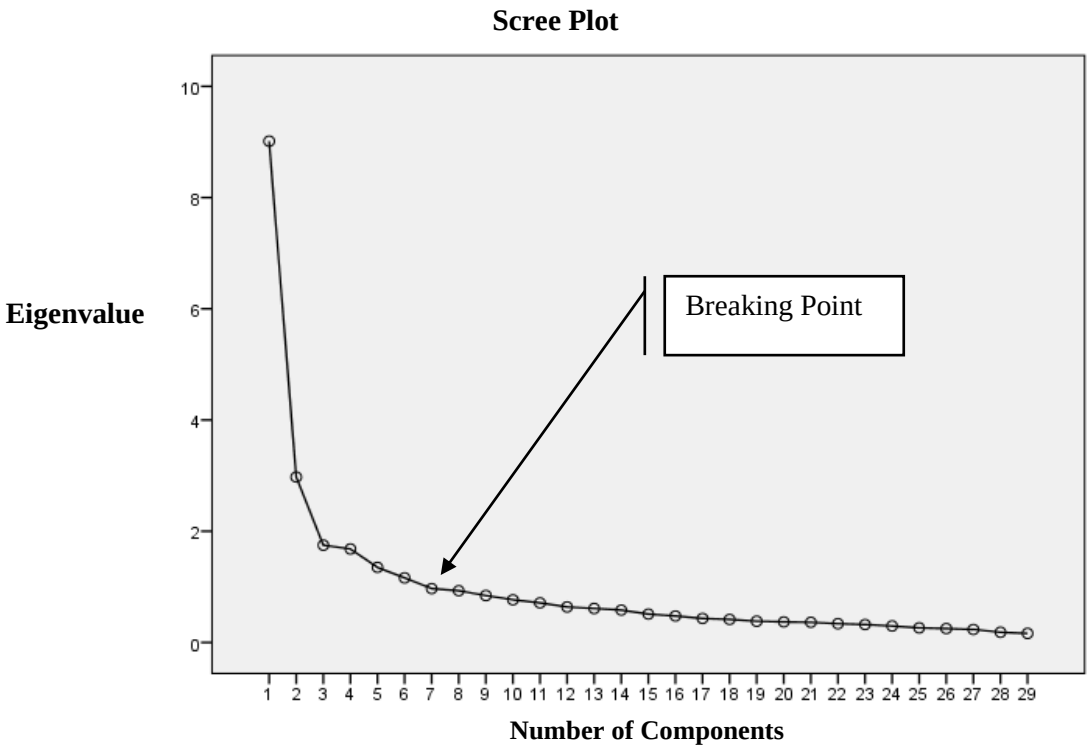

Figure 1. Digital Literacy Scale Scree Plot Graphic

As it can be seen in the scree plot graph, the declining acceleration of the values decreases after the sixth factor and continues almost horizontally. Both the component

matrix results and the scree plot results support that the digital literacy scale has a six-factor structure.

The six factors that emerged as a result of the factor analysis were examined in detail. While naming each factor, an overview meaning expressed by the items are taken into account. The items in Factor 1 were found to be related to behavioral norms regarding how users behave in online environments, whether they question the information they obtained, that is whether they made information confirmation, and whether their behavior had ethical, moral and legal responsibilities. In addition to this, it was observed that the items in factor 1 were related to whether digital content is moral and suitable for content awareness and the continuity of legal rights and freedoms in online environments. For this reason, factor 1 is named as "***Ethics and Responsibility***". The load values of the items in the ethical and responsibility factor are between 0.8 and 0.35. Büyüköztürk (2002) stated that regardless of whether the load values are negative or positive, those with an absolute load value of 0.6 and above are high; those between 0.3-0.59 are thought as medium level sizes. In this context, 4 of the items in the ethical and responsibility factor have high level relationship, 3 of the items have moderate relationship with relevant factor. Items under factor 2 include general information about software such as software and hardware information on digital technologies, licensed software, pirated software, malware. In addition, it has been observed that although not always necessary, technical issues that are needed from time to time are related to software and hardware practice. For example, to be able to format the computer, to change the Proxy / DNS settings of the device, to have both network knowledge and software knowledge and practice is for a more technical purpose. Therefore, factor 2 is named as ***"General Knowledge and Functional Skills"***. Having item load values between 0.83 and 0.61 indicates that six items belonging to general knowledge and functional skills have high significance. All of the items under factor 3 are related to the use of digital technologies in daily practice. Factor 3 is named as ***"Daily Usage"*** because it contains items related to e-citizenship, cloud technology, online broadcasting, reservation, shopping, Internet surfing and daily transactions. When the item load values of the factor were examined, it was concluded that it was between 0.55 and 0.72 and that one of the items had moderate significance values and the remaining five had high significance values. Both items in factor 4 include coding and product development, which are more advanced competence, to take part in

both the use of digital technologies and the production of digital technologies. This is why factor 4 is named as ***"Advanced Production"***. In the literature, there are different opinions about whether 2-item factors should be included in the scale or not. While Tabachnick and Fidel (2013); Widaman, Zhang and Hong recommending that factors should contain at least 3 item; Worthington, Whittaker, Büyüköztürk, Osborne and Anna suggest that two items under a single factor can be included after considering the relationship between them, the variance ratio explained by the relevant factor, and item load values. Accordingly, the item load values of the 2 items are (r = 0,81 and 0,77> 0,5) under the advanced production factor, their correlations are (α = 0,71> 0,7) and the explained variance (5,8%) was observed to be high. Therefore, two items are included as Advanced Production factor on the scale. The four items in Factor 5 are about users' protection of both their own and others' data in online environments. This factor is named as ***"Privacy and Security"*** as it consists of items related to phishing avoidance, privacy settings and ability to create strong passwords. When the item load values are examined, it is concluded that it is between 0.61-0.81 and all of the items have high significance values.

Lastly, it is observed that three of the four items in Factor 6 are related to content creation and modification, designing, communicating, collaborating and individual media publishing, one item is related to the users' ability to effectively use any software related to their work areas. This factor is named as the ***"Social Dimension"*** because it is related to both communication, collaboration, and the field of work. When the item load values of the social dimension are examined, it is concluded that it is between 0.52 and 0.75, and two of the items have moderate significance and the remaining two have high significance values.

3. 4. Reliability Analysis

The total variance which six factors of digital literacy scale explain is 61.84%. The size of the variance ratio that is explained reflects the strength of the factor structure of the developed scale. Reliability expresses the consistency of items in a measurement tool with each other and to what extent the scale that is used reflects the problem. In this study, *Cronbach Alpha* internal consistency coefficient is used to calculate whether the items are consistent with each other or not. As the coefficient gets closer to1, the reliability of

the measurement tool increases. According to Tavşancıl (2010), the coefficient should be at least 0.70 in order to claim that the scale is reliable and have internal consistency. *Cronbach Alpha* internal consistency value for the digital literacy scale is calculated as 0.91. This value shows that the scale is reliable and has internal consistency. The reliability coefficients of the sub-dimensions of the scale and the variance rates explained are given in Table 3.

Table 3. Rotated Load Values and Reliability Analysis of Digital Literacy Scale

Factors	Rotated Load Values			Reliability	
	Eigenvalue	Percentage of Variance %	Additive Percentage %	Cronbach Alpha	Number of Items
Ethics and Responsibility	9,01	31,08	31,08	0,842	7
General Knowledge and Functional Skills	2,97	10,26	41,34	0,875	6
Daily Usage	1,75	6,03	47,37	0,782	6
Advanced Production	1,68	5,8	53,17	0,719	2
Privacy and Security	1,35	4,66	57,83	0,82	4
Social Dimension	1,16	4,01	61,84	0,761	4
Digital Literacy Scale			**61,84%**	**0,911**	**29**

The Cronbach Alpha internal consistency analysis of the scale indicates that the reliability coefficient of ethics and responsibility dimension is calculated as $\alpha = 0.842$, general knowledge and functional skills dimension is calculated as $\alpha = 0.875$, daily use dimension is calculated as $\alpha = 0.782$, advanced production dimension is calculated as $\alpha = 0.719$, privacy and security dimension is calculated as $\alpha = 820$ and social dimension is calculated as $\alpha = 861$. In calculating the internal consistency coefficient, the lower limit value is taken as a=0.70 for the reliability of the measurement tool of Cronbach alpha value (Büyüköztürk, 2002; Karasar, 2016; Field, 2009; Tavşancıl, 2010). It is observed that alpha values for all sub-dimensions are greater than 0.70 and therefore the scale has sufficient reliability.

3. 5. Item-Total Item Correlation and Item Discrimination

Item-total correlation values for 29 items in the scale are found to be between 0.44 and 0.79. In addition, as a result of the Pearson Product Moment Correlation Analysis,

itis found out that all items in the scale have a significant relationship with the total score at the level of $p = 0.000 < 0.01$.

Item discrimination analysis is ranked in descending order according to the total scores obtained from the Likert Type scale and the scores of the participants, the upper 27% and the lower 27% were determined. Independent sample t-test was applied to see if the difference between the averages of the two groups is statistically significant. It is concluded that the scale statistically measures the difference between high-level and low-level groups in terms of digital literacy ($p = 0.00 < 0.05$).

3. 6. Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) has similar features with exploratory factor analysis. The purpose of exploratory factor analysis is to reveal the number of factors that underly the set of variables, the number of factors required to represent the data and the structure of items that are close to the factors. The presumption is that any variant can be linked to any factor. The purpose of confirmatory factor analysis is to statistically test the significance of the structure formed by a known number of factors and how well it represents the structure. In other words, Confirmatory Factor Analysis is used to check whether the sample data validates the proposed model or not (Brown, 2015). At the same time, it aims to test the factor or factors that emerge based on the relationships between variants (Tabachnick & Fidell, 2013).

In this study, the fit indices are examined to see if the digital literacy scale model that is developed is verified and whether the factors explain the model sufficiently and represent. According to Şencan (2005), Confirmatory Factor Analysis is used to test and / or verify theoretical knowledge. Digital Literacy scale with six factors and 29 items are used and data are collected from 1329 participants. 42 observations which are outliers are excluded from the analysis, and a confirmatory factor analysis is performed on the scale in the IBM SPSS Amos program with the data of 1287 participants.

While evaluating the results of the confirmatory factor analysis, it is evaluated by considering the indices such as CMIN / DF "$\chi 2$ / df", GFI, AGFI, RMSEA, RMR, SRMR, CFI NFI and IFI. While these values in the literature are reviewed, it is emphasized that instead of looking at a single value, it is necessary to take into account a number of values

together (Tabachnick & Fidell, 2013; Hair, Black, Babin, & Anderson, 2010; Byrne, 2001).

In the literature, if the ratio between chi-square goodness of fit and degrees of freedom is five or less, it is an indicator of an acceptable value (Hooper, Coughlan, & Mullen, 2008). It is also important to examine other model fit indices. GFI, CFI, NFI, RFI, IFI and AGFI indices, which are used when examining the fit of the model, their values range from 0 to 1. These values getting closer to 1 corresponds to the better fit. For RMSEA, 0.08 is accepted as an acceptable fit and 0.05 is accepted as a perfect fit value (Hooper, Coughlan, & Mullen, 2008; Çokluk, Şekercioğlu, & Büyüköztürk, 2018). Table 4 presents the acceptance criteria of fit indices and the fit values of developed Digital Literacy Scale values .

Table 4. Confirmatory Factor Analysis Model Fit Index Limit Values

Index	Acceptable Value	Digital Literacy Scale Value	Harmony
χ2/sd (Chi-Square Goodness of Fit Test)	<5	4,347	Acceptable
GFI (Goodness of Fit Index)	>0,90	0,919	Acceptable
AGFI (Adjusted Goodness of Fit Index)	>0,90	0,901	Acceptable
CFI (Comparative Fit Index)	>0,90	0,914	Acceptable
RMSEA (Root Mean Square Error of Approximation)	<0,08	0,051	Acceptable
RMR	<0,08	0,055	Acceptable
NFI (Normalized Fit Index)	>0,80	0,891	Acceptable
IFI (Increasing Fit Index)	>0,80	0,914	Acceptable

Source: Byrne, 2001; Çokluk, Şekercioğlu, & Büyüköztürk, 2018; Hair, Black, Babin, & Anderson, 2010; Yaşlıoğlu, 2017.

When fit indices obtained as a result of confirmatory factor analysis are reviewed; it is observed that operations can be made on the total scores obtained from the digital literacy scale and its sub-dimensions. In other words, as a result of the answers of the participants, the high scores obtained from overall scale or its sub dimensions indicate high digital literacy (Hamutoğlu, Güngören, Uyanık, & Erdoğan, 2017).

The Figure 2 shows the six factors of the digital literacy (represented by the circles). Each rectangle represents one item of the questionnaire, linked to its parent factor by a

single-headed arrow. The double-headed arrows connected to items 8, 9 and 1, 2 and 26, 27. This shows a covariance between two latent variables.

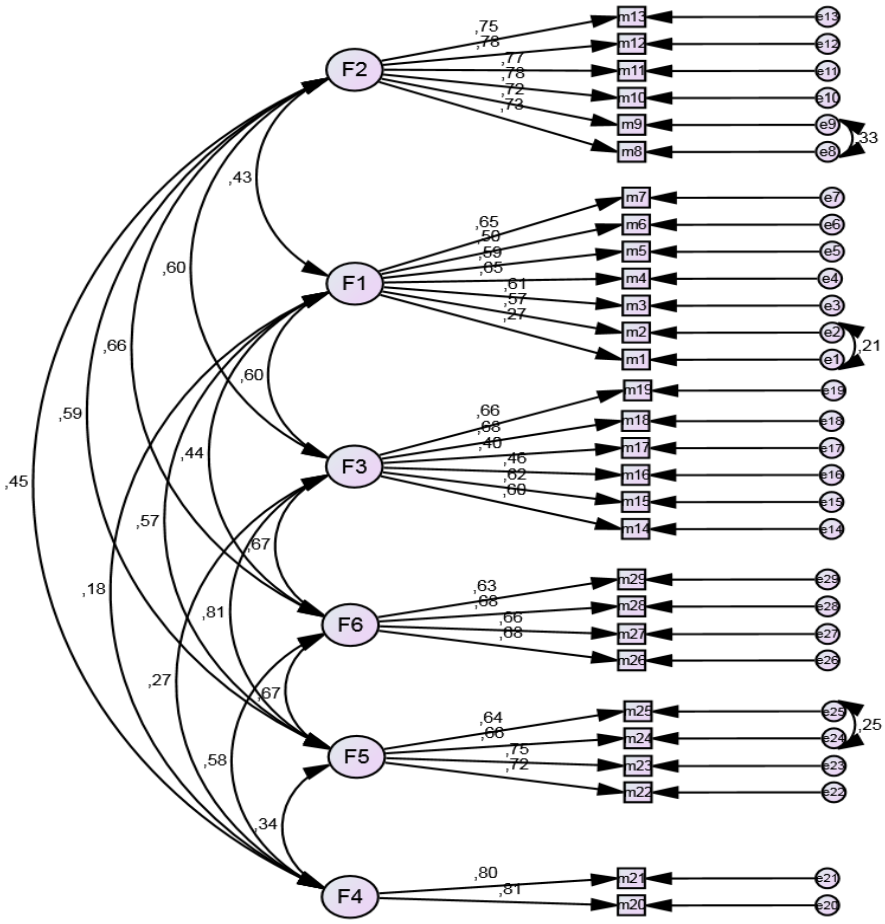

Figure 2. The diagram of the model

When the results that are obtained as a result of Confirmatory Factor Analysis are examined, it is seen that all fit indices used while testing the model have acceptable fit values. As a result, sufficient statistical results are obtained for the acceptance of the model. After confirming the model with Confirmatory Factor Analysis, reliability analysis is performed again, and Cronbach Alpha reliability is calculated as 0.91. In the study, the original Digital Literacy Scale with 29 items is developed. Digital Literacy Scale Model includes the factors and keywords that emerged as a result of this research which is given in Figure 3.

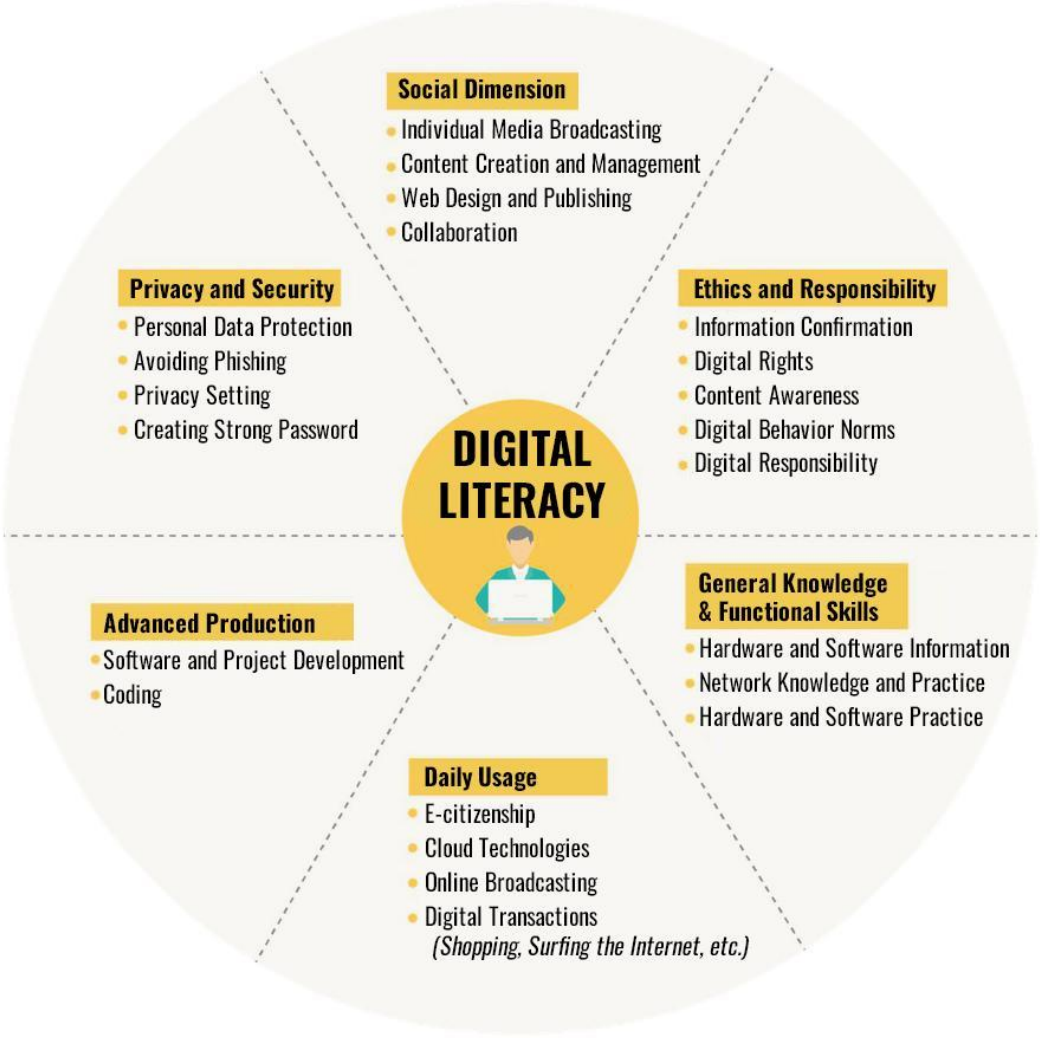

Figure 3. Digital literacy scale model

Evaluation of Digital Literacy Scores and Identification of Levels

Digital Literacy Scale is prepared in 5-point Likert type and competencies are rated between 1-5. The scores obtained from the scale, which has sufficient reliability and validity, allow an evaluation of the digital literacy of the participants. According to Baykul (2015), Erkan and Gömleksiz (2014), the evaluation is the process of making a judgment when the measurement results are compared with a criterion, and the use of appropriate criteria for the evaluation makes the decisions more accurate.

In this study, a standard score range was created to determine the digital literacy levels of university students and graduates. Therefore, it was thought that it is more appropriate to make a relative evaluation because the available data show normal distribution (Nartgün, 2007). In the relative evaluation, Z converting to standard score was preferred and as a result of Z scores, the cut-off scores of the scale were calculated and score ranges for the levels were calculated. Table 5 presents the statistically expected and observed values of the Digital Literacy Scale scores, the ranges resulting from the conversion of the scale scores to Z points and the levels recommended within the scope of the study.

Table 5. Digital Literacy Levels and Score Ranges

Frequency	% Observed	% Expected	Digital Literacy Scale Score Range	Z Score Range	Level Order	Digital Literacy Scale Level
85	6,6	6,7	1,62-3,07	Less than -1,5	1	Low/Poor
294	22,84	24,2	3,08-3,62	Between -1,5 and 0,5	2	Below Average/Weak
491	38,15	38,2	3,63-4,17	Between -0,5 and 0,5	3	Average
345	26,81	24,2	4,18-4,72	Between 0,51 and 1,5	4	Above Average/Good
72	5,59	6,7	4,73-5,00	Higher than 1,5	5	High/Perfect

Five different levels and the score ranges of these levels regarding the scale have been developed within the scope of the study. The tasks that can be undertaken by participants in the relevant competence were attempted to be represented concretely and European Digital Competence Framework 2.1. is used in order to summarize these levels and describe them more concretely.

Table 6. The Competencies of Digital Literacy Level

Digital Literacy Scale Score Ranges	Level	Competence
1,62-3,07	Low/Poor	S/he can perform simple and routine digital operations at the most basic level; It is the entrance level. He/She often needs the guidance of others.
3,08-3,62	Below Average/Weak	He/she is capable of solving uncomplicated routine tasks and clearly understand problems on his/her own.
3,63-4,17	Average	S/he is able to solve non-routine but not complicated problems on his own. S/he is intermediate in keeping up with the digital age and continues to learn.
4,18-4,72	Above Average/Good	S/he is a digital literate who can solve complex situations on his own and guide others in routine tasks. S/he can both apply and interpret digital technologies in his/her own life.
4,73-5,00	High/Perfect	S/he is at the level of expertise to be able to guide others in solving problems encountered in professional life and to propose or produce new ideas and processes related to work.

In the competencies levels, an individual has competencies which are take place in lower levels than him competencies level.

Discussion and Conclusion

This Digital Literacy Scale revealed the digital literacy levels of both university students and graduates in Turkey. The inadequacy of current digital literacy scales is the main problem in the emergence of this study. In addition, digital problems are the necessity of updating existing scales due to the continuous development of digital technologies. The current scales of digital literacy are generally aimed at education faculty students, middle school and high school groups, that means, there is no comprehensive scale that can be applied to larger samples, and lastly, the existing scales have a weak representation of the digital competencies of university students and graduates.

Models and scales in the literature on digital literacy were examined. It is noteworthy that the existing scales of digital literacy, which are generally used in academic studies in the field of educational sciences in the literature in Turkish, have become outdated due to developing digital technologies. In addition, it is determined that there is no information about whether these scale studies fully implement the scale development processes. Considering these situations, a scale has been developed that is both current and suitable for scale development processes. Digital Literacy Scale consists

of 29 items and 6 sub-dimensions (a. Ethics and Responsibility, b. General Information and Functional Skills, c. Daily Use, d. Advanced Production, d. Privacy and Security, e. Social Dimension). Confirmatory factor analysis was applied with the main application and it was concluded that all values of the structural validity of the scale model were at acceptable levels. Thus, the reliability validity of Digital Literacy Scale has been tested and approved.

Compared with other scales in the literature, the Ethics and Responsibility dimension has similar characteristics with is the “self-awareness” dimension of Almås and Krumsvik (2007); the "ethical" dimension of Calvani, Fini, and Ranieri (2009); the “ethical” dimension of Chetty et al. (2017); Ng's (2012) "cognitive" dimension; Hobs' (2010) "reflecting/expressing" dimension; Hague and Payton's (2010) "critical thinking and evaluation" component; and the "legal and ethical aspects" dimension of Janssen, Stoyanov, Ferrari, Pannekeet, and Sloep (2012). General Information and Functional Skills dimension is similar with the “technological” dimension of Calvani, Fini and Ranieri (2009); the “technical” dimension of Chetty et al. (2017); the “technical” dimension of Ng (2012); the “functional skills” of Hague and Payton (2010); and finally the "general knowledge and functional skills" dimension of Janssen, Stoyanov, Ferrari, Pannekeet and Sloep (2012). The Daily Use dimension is similar to the "Use in everyday life" competence in Janssen, Stoyanov, Ferrari, Pannekeet, and Sloep's (2012) digital literacy scale. Although the Advanced Production dimension has not yet been fully covered in the literature, Martin's (2008) "digital transformation", which is at the top of digital literacy levels, and Janssen, Stoyanov, Ferrari, Pannekeet and Sloep's (2012) model "specialized and advanced competence for work & creative expression." Privacy and Security dimension has similar characteristics with Chetty et al.'s (2017) “ethical” dimension; Ng’s (2012) “cognitive” and “social-emotional” dimensions; Hague and Payton (2010) “e- safety” component and the “privacy and security” dimension of Janssen, Stoyanov, Ferrari, Pannekeet, and Sloep (2012). Lastly, The Social Dimension is extensive and is related to Ng's (2012) "social-emotional" dimension, Hobs (2010) "content creation and collaboration" dimension, Hague and Payton (2010) "effective communication", "collaboration" and " creativity” dimensions and Janssen, Stoyanov, Ferrari, Pannekeet and Sloep’s (2012) “technology-mediated communication & collaboration” dimension.

There are no fixed and stable criteria in the literature regarding what to base on or what to evaluate when deciding on the digital literacy level of the participants. By converting the participants' total scores from the Digital Literacy Scale to Z standard score, their digital literacy levels (low, below-medium, medium, above-medium, and high) were identified and the score ranges for the levels were revealed.

Due to the development of digital technologies and the fact that various items on the scale will become outdated over time, it is recommended that researchers systematically update the scale in accordance with technological developments and the needs of the society.

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Digital Literacy Scale

This scale, developed as a part of dissertation, aims to determine the digital literacy levels and sub-dimensions of undergraduate students and individuals who have completed bachelors' degree. In below, there are various activities about digital literacy. Please carefully read the given competencies and select the option that suits your level.

The data collected for academic purposes from this scale will not be shared with other individuals and institutions. If you fill it sincerely, you will make a great contribution to reaching the right data. Do not leave any item blank. Thank you in advance for your interest and contribution.

	DIGITAL LITERACY SCALE	**I Strongly Disagree**	**I Disagree**	**I am Uncertain**	**I Agree**	**I strongly Agree**
Ethic and Responsibility	I am aware that my personal or legal rights (privacy, copyright, freedom of speech, etc.) continue in digital media as well as in daily life.	1	2	3	4	5
	I know how to behave to protect others' and own personal data (photo, address, family information, etc.) online	1	2	3	4	5
	I can inquire from different sources whether the information I accessed online is correct or not.	1	2	3	4	5
	I am aware of the ethical and legal responsibilities such as cyberbullying (insult, swearing, hate speech, etc.) and online abusing.	1	2	3	4	5
	I can recognize digital games and content that are suitable for cognitive and moral development.	1	2	3	4	5
	I am aware that everything I do online is recorded.	1	2	3	4	5
	I am aware of the ethical and legal responsibilities that may arise from copyright violations in digital environments.	1	2	3	4	5
General Knowledge and Functional Skills	I know the concepts such as licensed software, demo software, pirated software, malware, crack etc.	1	2	3	4	5
	I know what hardware and software technologies mean.	1	2	3	4	5
	I can install / format the operating system on my computer.	1	2	3	4	5
	I can install software or programs on my computer or other electronic devices	1	2	3	4	5
	I know what Torent, Internet, World Wide Web (WWW) terms mean.	1	2	3	4	5

	I can change the proxy /dns settings of devices to access banned websites.	1	2	3	4	5
	I can effectively use e-Government applications (MHRS, UYAP, tax & penalty inquiry etc.)	1	2	3	4	5
	I can use cloud computing technologies (Google Drive, iCloud, Dropbox, etc.) effectively in daily life.	1	2	3	4	5
	I can use the calendar on mobile devices not only just for looking at date but also as reminder, for taking notes	1	2	3	4	5
Daily Usage	and creating events.					
	I can do activities such as "uploading videos / broadcasting" online.	1	2	3	4	5
	I can use digital technologies effectively in daily practice such as reservation, shopping, address finding etc.	1	2	3	4	5
	I can add a web page that I use to bookmarks or favorites.	1	2	3	4	5
	I can develop software / applications based on digital technologies.	1	2	3	4	5
Advanced Production	I can use at least one programming language (Java, C, Visual Basic, PHP, etc.).	1	2	3	4	5
	I know how to restrict apps' access to my personal information (location, contacts, camera, etc.)	1	2	3	4	5
Privacy and Security	I can recognize and block unwanted / spam emails and phishing messages.	1	2	3	4	5
	I can change the privacy / security settings on my social media posts and profile.	1	2	3	4	5
	I know how to create a strong password.	1	2	3	4	5
	I can design and publish a website using web design systems (Weebly, WordPress, etc.)	1	2	3	4	5
	I can write and share on my own blog page or on different blogs.	1	2	3	4	5
Social Dimension	With the help of digital technologies, I can change various images (photography, sound recording and video, etc.) and produce new content.	1	2	3	4	5
	I can effectively use at least one software related to my field (Photoshop, SPSS, Premiere, Office Word, etc.).	1	2	3	4	5

Dijital Okuryazarlık Ölçeği

Doktora kapsamında geliştirilen bu ölçek lisans öğrencileri ve lisans eğitimini tamamlamış bireylerin dijital okuryazarlık düzeylerini ve alt boyutlarını belirlemeyi amaçlamaktadır. Aşağıda dijital okuryazarlığa dair çeşitli yetkinlikler yer almaktadır. Lütfen verilen yetkinlikleri dikkatle okuyarak kendi düzeyinize uygun olan seçeneği işaretleyiniz.

Akademik amaçla geliştirilen bu ölçekten toplanan veriler kesinlikle başka kişi ve kurumlarla paylaşılmayacaktır. İçtenlikle doldurduğunuz takdirde doğru verilere ulaşılmasında büyük katkılarınız olacaktır. Hiçbir maddeyi boş bırakmayınız. Göstereceğiniz ilgi ve katkılarınız için şimdiden teşekkür ederim.

	DİJİTAL OKURYAZARLIK ÖLÇEĞİ	**Kesinlikle Katılmıyorum**	**Katılmıyorum**	**Kararsızım**	**Katılıyorum**	**Kesinlikle Katılıyorum**
Etik ve Sorumluluk	Günlük hayatta olduğu gibi dijital ortamlarda da kişisel veya yasal haklarımın (mahremiyet, telif, konuşma özgürlüğü vb.) devam ettiğinin farkındayım.	1	2	3	4	5
	Çevrim içi ortamlarda kendimin ve başkalarının kişisel verilerini (fotoğraf, adres, aile bilgileri vb.) korumak için nasıl davranmam gerektiğini bilirim.	1	2	3	4	5
	Çevrim içi ortamlarda eriştiğim bilgilerin doğru olup olmadığını farklı kaynaklardan sorgulayabilirim.	1	2	3	4	5
	Çevrim içi ortamlarda siber zorbalık (aşağılama, küfür, nefret söylemi vb.) ve istismar gibi davranışların etik ve yasal sorumluluklarının farkındayım.	1	2	3	4	5
	Bilişsel ve ahlakî gelişime uygun olan dijital oyunları ve içerikleri ayırt edebilirim.	1	2	3	4	5
	Çevrim içi ortamlarda yaptığım her şeyin kaydedildiğinin farkındayım.	1	2	3	4	5
	Dijital ortamlarda telif haklarının ihlalinden doğabilecek etik ve yasal sorumlulukların farkındayım.	1	2	3	4	5
Genel Bilgi ve İşlevsel Beceriler	Lisanslı yazılım, demo yazılım, korsan yazılım, kötü amaçlı yazılım ve crack kavramlarının ne olduğunu bilirim.	1	2	3	4	5
	Donanım ve yazılım teknolojilerinin ne olduğunu bilirim.	1	2	3	4	5
	Bilgisayarıma işletim sistemini kurabilirim/format atabilirim.	1	2	3	4	5
	Bilgisayarıma ya da diğer elektronik cihazlarıma yazılım veya program yükleyebilirim.	1	2	3	4	5
	Torent, İnternet, World Wide Web (WWW) ifadelerinin ne anlama geldiğini bilirim.	1	2	3	4	5
	Yasaklı İnternet sitelerine erişmek için cihazların proxy/dns ayarlarını değiştirebilirim.	1	2	3	4	5
Günlük Kullanım	e-Devlet uygulamalarını (MHRS, UYAP, vergi&ceza sorgulama vb.) etkin kullanabilirim.	1	2	3	4	5
	Bulut bilişim teknolojilerini (Google Drive, iCloud, Dropbox vb.) günlük hayatta etkin kullanabilirim.	1	2	3	4	5
	Mobil cihazlarda takvimi sadece tarihe bakmak için değil; aynı zamanda anımsatıcı, not alma, etkinlik oluşturma vb. işler için de kullanabilirim.	1	2	3	4	5

	Çevrim içi ortamlarda "video yüklemek/canlı yayın yapmak" gibi etkinliklerde bulunabilirim	1	2	3	4	5
	Rezervasyon, alışveriş, adres bulma vb. gündelik pratiklerde dijital teknolojileri etkin kullanabilirim.	1	2	3	4	5
	Kullandığım bir web sayfasını sık kullanılanlara veya yer imlerine ekleyebilirim.	1	2	3	4	5
Profesyonel Üretim	Dijital teknolojilere dayalı yazılım/uygulama geliştirebilirim.	1	2	3	4	5
	Programlama dillerinden (Java, C, Visual Basic, PHP, vb.) en az birini kullanabilirim.	1	2	3	4	5
Gizlilik ve Güvenlik	Uygulamaların kişisel bilgilerime (konum, rehber, kamera vb.) erişimini kısıtlamayı bilirim.	1	2	3	4	5
	İstenmeyen/spam epostaları ve oltalama mesajları tanıyıp engelleyebilirim.	1	2	3	4	5
	Sosyal ağlardaki paylaşımlarımda ve profilimdeki gizlilik/güvenlik ayarlarını değiştirebilirim.	1	2	3	4	5
	Nasıl güçlü bir şifre oluşturacağımın farkındayım.	1	2	3	4	5
Sosyal Boyut	Web tasarım sistemlerini (Weebly, Wordpress vb.) kullanarak İnternet sitesi tasarlayıp yayınlayabilirim.	1	2	3	4	5
	Kendi blog sayfamda veya farklı bloglarda yazı yazıp, paylaşabilirim.	1	2	3	4	5
	Dijital teknolojiler yardımıyla çeşitli imajları (fotoğraf, ses kaydı ve video vb.) değiştirip, yeni içerikler üretebilirim.	1	2	3	4	5
	Alanımla ilgili en az bir tane yazılımı (Photoshop, SPSS, Premiere, Office Word vb.) etkili bir şekilde kullanabilirim.	1	2	3	4	5