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Research Paper

Digital Intelligence Child Scale Validity and Reliability Study*

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ABSTRACT

The study focused on examining the validity and reliability of the 'Digital Intelligence Child Scale.' The general screening model was used to test the validity and reliability of the scales organized as "Digital Intelligence Level 1 Child Scale" for illiterate children and "Digital Intelligence Level 2 Child Scale" for literate children. The sample of the study consisted of parents of 979 children aged 4-5 with typical development and 6-8 who were literate and attending kindergartens/preschools and primary schools affiliated with the Ministry of National Education in the city center of Ankara during the spring term of the 2021–2022 academic year and the autumn term of the 2022–2023 academic year. Following the analyses related to scope and validity, two scales were derived: the 'Digital Intelligence Level 1 Children's Scale' with 29 items and 4 subdimensions, and the 'Digital Intelligence Level 2 Children's Scale' with 44 items and 7 subdimensions. The four-factor structure identified for the Digital Intelligence Level 1 Children's Scale accounted for 66.83% of the total variance, while the seven-factor structure determined for the Digital Intelligence Level 2 Children's Scale explained 71.46% of the total variance. According to the confirmatory factor analysis, the CFI value was found to be 0.97 and the NFI value was found to be 0.93 for the Digital Intelligence Level 1 Children's Scale, while the CFI value was found to be 0.98 and the NFI value was found to be 0.97 in the Digital Intelligence Level 2 Children's Scale. To assess the reliability of the scales, Cronbach's alpha coefficients were calculated and found to be 0.94 for the Digital Intelligence Level 1 Children's Scale and 0.96 for the Digital Intelligence Level 2 Children's Scale. Accordingly, the 'Digital Intelligence Level 1 Child Scale' and the 'Digital Intelligence Level 2 Child Scale' were concluded to be both valid and reliable.

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INTRODUCTION

In the digitalized world of the 21st century, children have become active participants in a period shaped by the rapid advancement of technology. Devices such as smartphones, tablets, and computers have become integral components of children's everyday activities and educational experiences. Providing a wider information and communication network, these devices transform and enrich children's learning processes, while also radically changing their lives and introducing them to a wider digital world than ever before. While the number of children using digital technologies is increasing day by day, the age at which they are introduced to these tools is decreasing. According to Hague and Payton (2010), children as young as four years old have begun to use a wide variety of digital technology tools. Some studies show that preschool children are exposed to digital tools before they are introduced to books. International trends show that children are increasingly using digital tools and the age at which they first use them is decreasing (Hopkins et al., 2013; Hooft Graafland, 2018). It is observed that children tend to have their first experiences with digital technologies before the age of two, in many cases even before they can talk or walk (Burns & Gottschalk, 2020; Joint Research Centre, 2018). Therefore, the rapid adoption of these digital tools has led to a critical increase in the rate of children spending time with digital games, online applications and content in many societies (Prensky 2001; Rideout 2013; Vandewater et al. 2007; Vandewater & Lee 2009).

In the traditional period when digital technologies were not as developed as they are today, children spent most of their time playing street games and physically interacting with their peers (Güleç, 2018). Nevertheless, contemporary data indicate a substantial rise in the duration that children, born into the era of digital technology, engage with digital devices (Communications, 2016). Thanks to the user-friendly design and simple use of digital technologies, children of all ages can easily access many content such as videos, games and animations (Lynch & Redpath, 2014). Across Organisation for Economic Co-Operation and Development (OECD) countries, the proportion of children who first met the internet before the age of six increased from 15 per cent in 2012 to 18 per cent in 2015. In 2018, according to the data obtained, this rate reached approximately 40% (OECD, 2017; OECD 2019). On the other hand, studies have evaluated the months of children's acquaintance with digital technologies and it was observed that children were exposed to television at the age of 7 months, started spending time with computers at the age of 13 months and tablets at the age of 25 months (Durmuş & Övür, 2021). Johnson (2010), in a study carried out in Hong Kong, reported that nearly 90% of preschool-aged children were exposed to computers either at home or in educational settings. According to data from the

international early learning study, on average in 2018 in three participating countries (the United Kingdom, Estonia and the United States), 83 per cent of 5-year-olds used digital tools at least once a week, 42 per cent used digital tools every day and only 7 per cent never used digital tools (OECD, 2020). According to Common Sense Media, children under the age of two in the United States are exposed to digital media for 42 minutes a day, 17 per cent of which is on mobile devices (Common Sense, 2017). With increasing access to digital media, children are also spending more time in digital media. Overall, over the last decade, the average amount of time children spend online has doubled in some countries, including France, Italy, Germany, Spain and Portugal. This is because more and more children own digital devices such as smartphones (Burns & Gottschalk, 2020; Smahel et al., 2020). The situation is similar in Turkey. Based on the findings of the Household Information Technology Usage Survey conducted by the Turkish Statistical Institute (TURKSTAT), the percentage of households with internet access at home rose by 1.4 percentage points in 2023 compared to the previous year, reaching 95.5%. According to the results of the survey on the use of information technologies among children, internet use for children in the 6-15 age group increased from 50.8% in 2013 to 91.3% in 2024. The proportion of children in the 6-15 age group who stated that they use mobile phones/smartphones increased to 76.1% in 2024. While the proportion of children in the 6-15 age group using tablet computers was 7.3% in 2013, this rate was 57.2% in 2021 (TURKSTAT, 2013; TURKSTAT, 2021; TURKSTAT, 2023; TURKSTAT, 2024). The duration of children's exposure to digital tools in Turkey and in the world is increasing at an increasing pace and is similar.

Despite the American Academy of Pediatrics (AAP) recommending that children limit their use of digital devices to under two hours per day to mitigate potential developmental risks, this guideline is exceeded by nearly 50% of children in numerous developed countries (AAP, 2011; AAP, 2013). Although this situation provides advantages in some cases in terms of children's development, it also causes some disadvantages For instance, engagement with digital tools has been shown to facilitate learning processes such as alphabet recognition, reading proficiency, and the development of language and mathematical abilities (Jackson et al., 2011). Additionally, digital tool usage can enhance cognitive functions, including visual intelligence and psychomotor skills (Li et al., 2006). According to Bremer (2005), the use of digital tools supports foreign language learning and development especially in early childhood and accelerates hand-eye-mind coordination. In addition to these, digital tools provide children with the freedom to express themselves and allow them to demonstrate their abilities such as productivity, creativity and design (Bremer, 2005). In addition to these advantages of using digital tools in favour of children, there are also many disadvantages. When the duration of use of these tools is not observed, children may experience effects such as weakening of mental skills, isolation from social life, practical thinking, artistic activity, and narrowing of the imagination (Radesky & Christakis, 2016). In addition, unconscious use of digital tools may cause violations of children's rights, failure to protect privacy and damage to social values. Especially in online environments connected with digital tools, children may face sexual, emotional and physical abuse and bullying situations due to inappropriate content they may encounter (Ateş & Saluk, 2018; Karadeniz & Özdemir, 2018; Serin, 2019).

Considering that digital technology use will increase in the coming years and that this will further affect children's daily lives and educational situations, it is important to prevent or minimise the harms as well as the benefits they provide to children. It is essential to equip children with the competencies required to effectively utilize the opportunities offered by digital tools, as well as to manage potential challenges and risks. According to this requirement, in 2019, the World Economic Forum (WEF), the Digital Intelligence Institute (DQ Institute), the Organisation for Economic Co-operation and Development (OECD) and the Institute of Engineers and Everyone Else (IEEE) Standards jointly defined the concept of 'Digital Intelligence' and explained the skills that make up the content of this concept (DQ Institute, 2019). Digital intelligence (DQ) is characterized as an integrated collection of technical, cognitive, meta-cognitive, and socio-emotional competencies grounded in universal ethical principles, which empower individuals to confront the challenges of digital life and adapt to its demands (IEEE Standards Association, 2020). These skills are grouped into three levels: 'digital citizenship', 'digital creativity' and 'digital competitiveness'. Eight skills corresponding to each level are reported. These are digital identity, digital usage, digital security, digital safety, digital emotional intelligence, digital literacy, digital communication and digital rights (IEEE Standards Association, 2020).

Digital intelligence skills enable children to be active and conscious users rather than passive users in digital tools and online environments. In addition, it is possible for children to be more creative and safe users in their interactions with digital tools with digital intelligence skills. From this point of view, children should be made aware of the use and safety of digital tools. While children's autonomy and awareness in using digital tools provide benefits especially in online environments, they are also known to be protected against risks (Livingstone, 2015). Consequently, enhancing children's awareness, knowledge, and competencies regarding the effective, efficient, and appropriate use of digital tools and the Internet is of paramount importance. This has become a priority approach in terms of healthy development of children and protection from the risks and negativities of digital tools and the internet in the world of the future. It will be possible for children who have the skills that make up digital intelligence to grow up as enlightened, researcher, emotionally and physically healthy individuals who catch the developments in the world. Because life in the 21st century is much more technology-oriented and digital intelligence skills have become the basic requirements of life. As a matter of fact, OECD (2018) and World Economic Forum-WEF (2020) have defined these skills as fundamental in the world of the future. However, with the acceleration of technological advances, the support of individuals' digital intelligence skills remains slow. The speed difference between these increasing digital intelligence skill needs of children and the educational policies developed for this is also growing (Park, 2019). In this context, education systems need to recognise children's interactions with digital tools and support them to benefit from these tools. In order to provide this support, it is important to determine the current status of digital intelligence skills at children's developmental levels. Knowing which and how much digital intelligence skills are needed in children will contribute to the development of educational policies. Hence, there is a need for a valid measurement and

evaluation instrument to assess digital intelligence skills during childhood. This assessment instrument should be designed with a comprehensive approach that serves as a foundation for acquiring children's digital intelligence skills, identifying their digital intelligence levels, and guiding the advancement of these competencies.

When the literature is reviewed, there are studies stating that the conceptual analysis of digital intelligence and its evaluation with appropriate measurement tools will greatly enable raising individuals with sufficient qualifications in the digital world. In the face of the increasingly complex structures of developing digital technologies, it is predicted that digital intelligence will evolve into the most necessary type of intelligence (Bak, 2020; Stiakakis, et al., 2019; Van Laar et al., 2017). Since there are no tools in the literature aiming to measure digital intelligence skills for children, there is a need for valid and reliable measurement tools in this field. It is thought that whether children can read and write is important in terms of the evaluation criteria of digital intelligence skills. For this reason, measurement and evaluation tools organised separately for children who can read and write and preschool children who are not yet able to read and write will enable more accurate evaluation of digital intelligence. Therefore, it is thought that the 'Digital Intelligence Level 1 Child Scale' for illiterate preschool children and the 'Digital Intelligence Level 2 Child Scale' for literate children developed by the researchers in this study will contribute to the field of digital intelligence skills of children. From this point of view, examining the validity and reliability of the 'Digital Intelligence Level 1 Children's Scale' and 'Digital Intelligence Level 2 Children's Scale' constitutes the problem statement of this research.

METHOD

The primary objective of this study was to examine the validity and reliability of the 'Digital Intelligence Child Scale'. Aligned with this objective, this section of the study provides detailed explanations regarding the research model, study sample, validity and reliability assessments, as well as data collection and analysis procedures.

Research Design

In this research, the general survey model was used. General survey models are research designs conducted on either the entire population or a selected sample from it, with the aim of reaching general conclusions about the population, especially in cases where the population consists of a large number of elements. (Karasar, 2014, p.79). In this context, a sample was determined to represent the universe in this study conducted with the general screening model.

Population and Sample

The study sample comprised parents of typically developing children aged 4 to 5 years, as well as literate children aged 6 to 8 years, who were enrolled in kindergartens, preschools, and primary schools affiliated with the Ministry of National Education in the central district of Ankara during the spring semester of the 2021–2022 academic year and the autumn semester of the 2022–2023 academic year. In the formation of the study group, a list of kindergartens/preschools and primary schools affiliated to the Ministry of National Education in Ankara city centre was obtained from the Ankara Provincial Directorate of National Education. The principals and teachers of the selected schools were interviewed one by one and asked whether they were willing to contribute to this study. They were made aware of the study's objectives, the application phases, and the items included in the scales. A total of 403 parents with children between the ages of 4-6 were included in the study for the 'Digital Intelligence Level 1 Child Scale' and 576 parents with children between the ages of 6-8 were included in the study for the 'Digital Intelligence Level 2 Child Scale'.

Data Collection Tools

In this section, data collection tools and data collection processes are discussed. A personal information form containing personal information about children and their families, Digital Intelligence Level 1 Child Scale' to assess the digital intelligence of illiterate children and 'Digital Intelligence Level 2 Child Scale' to assess the digital intelligence of literate children were used to collect the data of the study.

'Digital Intelligence Level 1 Child Scale' was developed by the researchers and was related to preschool children aged 4-6 years and was completed by the parents of each child. The 'Digital Intelligence Level 2 Child Scale' was also developed by researchers and was related to children aged 6-8 years with literacy skills and was also filled in by parents. In light of this information, the 'Digital Intelligence Level 1 Child Scale' was composed of a total of 37 items in 5 sub-dimensions. The sub-dimensions consist of Digital Citizen Identity (8 items), Balanced Use of Technology (7 items), Behavioral Cyber Risk Management (8 items), Personal Cyber Security Management (6 items), and Media and Information Literacy (8 items). The definitions of these sub-dimensions are provided as follows;

Digital Citizen Identity: The ability to create and manage a healthy online identity as an individual with integrity who uses digital technology responsibly, ethically and safely.

Balanced Use of Technology: The capacity to regulate and harmonize online and offline activities by exercising self-control over screen time, multitasking, and engagement with digital media and devices.

Behavioural Cyber Risk Management: The competence to recognize, reduce, and handle cyber risks associated with individual online behaviors, such as cyberbullying, harassment, and stalking.

Personal Cyber Security Management: Ability to identify cyber threats to personal data and devices (e.g. hacking, fraud and malware) and use appropriate security strategies and protection tools.

Media and Information Literacy: The skill to locate, organize, analyze, and critically evaluate media content and information.
The measurement tool was prepared in the form of a 5-point Likert scale as 'Never', 'Rarely', 'Sometimes', 'Frequently' and 'Always'.

'Digital Intelligence Level 2 Child Scale' is composed of 67 items under 8 sub-dimensions. These sub-dimensions are Digital Citizen Identity with 10 items, Balanced Use of Technology with 8 items, Behavioural Cyber Risk Management with 10 items, Personal Cyber Security Management with 8 items, Privacy Management with 6 items, Media and Information Literacy with 11 items, Digital Footprint Management with 6 items and Digital Empathy with 8 items. In addition to the dimensions defined in the 'Digital Intelligence Level 1 Child Scale', the following dimensions were added:

Privacy Management: Ability to protect the privacy of self and others
Digital Footprint Management: The capability to comprehend the nature and tangible impacts of digital footprints, responsibly manage them, and proactively cultivate a positive digital reputation.
Digital Empathy: The ability to recognise, be sensitive to and supportive of one's own and others' feelings, needs and concerns online.

In the next stage, the content validity of the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale' was performed. Content validity refers to the appropriateness of the items in the scale and the degree to which they measure the intended construct, typically determined based on expert judgment. At this point, the scale draft was submitted to the evaluation of nine experts on content validity and appropriateness of the content. The experts were asked to criticise the appropriateness and comprehensibility of the scale for the purpose of the research and to express their opinions about the change, correction or removal of the items when they found it necessary. The expert form was presented in accordance with the three-point Likert-type evaluation criteria as 'Appropriate', 'Not appropriate', 'Should be corrected'. The items that the experts found appropriate with the consensus of the experts were taken unchanged. The items that the experts suggested to be modified were analysed by the researcher and the consultant lecturer and the necessary changes were made in line with the opinions and the scale was finalised.

Data Collection Process

A pilot study was conducted in a school randomly selected from the selected schools to test the comprehensibility of the items in the tool and then the scale was applied. At this stage, the research sample included 50 parents with children aged 4–6 for the "Digital Intelligence Level 1 Child Scale" and 50 parents with children aged 6–8 for the "Digital Intelligence Level 2 Child Scale." In the pre-test, feedback was collected regarding the clarity and comprehensibility of the scale items. For the test administration and Exploratory Factor Analyses (EFA), data were collected from 238 parents of children aged 4 to 6 for the 'Digital Intelligence Level 1 Child Scale' and 304 parents of children aged 6 to 8 for the 'Digital Intelligence Level 2 Child Scale'; for the Confirmatory Factor Analyses (CFA), the sample consisted of 165 parents of children aged 4 to 6 for the 'Digital Intelligence Level 1 Child Scale' and 273 parents of children aged 6 to 8 for the 'Digital Intelligence Level 2 Child Scale'. Consequently, the study included a total of 403 parents of children aged 4 to 6 for the 'Digital Intelligence Level 1 Child Scale' and 576 parents of children aged 6 to 8 for the 'Digital Intelligence Level 2 Child Scale'.

Table 1. characteristics of the group participating in the digital intelligence level 1 child scale trial

		N	%
Parenting Role	Mother	185	77,73
	Father	53	22,27
Child Gender	Female	96	40,34
	Male	142	59,66

Table 1 reveals that 77.73% (n = 185) of the parents who completed the Digital Intelligence Level 1 Child Scale were the mothers of the children and 22.27% (n = 53) were the fathers. It was determined that 40.34% (n = 96) of the participants were girls and 59.66% (n = 142) were boys.

Table 2. characteristics of the group participating in the digital intelligence level 2 child scale trial

		N	%
Parenting Role	Mother	239	78,88
	Father	64	21,12
Child Gender	Female	153	50,50
	Male	150	49,50

As illustrated in Table 2, it is seen that 78.88% (n = 239) of the parents who completed the Digital Intelligence Level 2 Child Scale were the mothers of the children and 21.12% (n = 64) were the fathers. The participant distribution was 50.50% girls (n = 153) and 49.50% boys (n = 150).

During the next phase, data were gathered from 165 parents with children aged 4–6 for the 'Digital Intelligence Level 1 Child Scale' and 273 parents with children aged 6–8 for the 'Digital Intelligence Level 2 Child Scale' to validate the scale structures through confirmatory factor analysis and main application.

Table 3. characteristics of the group participating in the digital intelligence level 1 child scale main application

		N	%
Parenting Role	Mother	136	82,42
	Father	29	17,58
Child Gender	Female	89	53,94
	Male	76	46,06

Table 3 reveals that 87.42% (n = 136) of the parents who completed the Digital Intelligence Level 1 Child Scale were the mothers of the children and 17.58% (n = 29) were the fathers. The participant distribution showed that 53.94% (n = 89) were boys and 46.06% (n = 76) were girls.

Table 4. characteristics of the group participating in the digital intelligence level 2 child scale main application

		N	%
Parenting Role	Mother	230	84,25
	Father	43	15,75
Child Gender	Female	144	52,75
	Male	129	47,25

Table 4 reveals that 84.25% (n = 230) of the parents who completed the Digital Intelligence Level 2 Child Scale were the mothers of the children and 15.75% (n = 43) were the fathers. The participant distribution showed that 52.75% (n = 144) were boys and 47.25% (n = 129) were girls.

The data collection process was carried out face-to-face and online via Google Form from children attending 1st and 2nd grades of public and private kindergartens and primary schools in the central districts of Ankara province and their parents. Procedures pertaining to the process were conducted during the spring semester of the 2021–2022 academic year and the fall semester of the 2022–2023 academic year, and the 'Digital Intelligence Level 1 Child Scale' lasted 6-10 minutes, and the 'Digital Intelligence Level 2 Child Scale' lasted 14-18 minutes.

Data Analysis

The "Personal Information Form", 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale' data were transferred to the computer environment and the necessary statistical analyses were performed. In the analyses, the data were evaluated using SPSS / Lisrel Package programs.

Data obtained through the trial application were used to reveal the relationships between the items and the features to be measured and to evaluate the items. To examine the relationship between the item and the construct, the Pearson correlation coefficient between the item score and the total score was calculated in this study. The structural validity of the developed measurement tool was examined using Factor Analysis, which is one of the multivariate statistical analysis techniques widely employed in psychometrics (Hair et al., 2018). Exploratory Factor Analysis (EFA) was used to reveal the construct validity for the trial application. The analysis was performed with the IBM SPSS 25 program. Before performing exploratory factor analysis, KMO (Kaiser-MEyer-Olkin) and Bartlett statistics values (KMO=0.892; Bartlett's statistic = 5337.445/sd=666/p<0.001) were determined and it was determined that the sample size was adequate for factor analysis. Factor analysis was performed based on principal components analysis. Assuming that there was a relationship between factors, the promax rotation method was used. While performing exploratory factor analysis, items with factor loadings of 0.30 and items that gave close factor loadings on more than one factor at the same time (overlapping items) were excluded from the analysis and exploratory factor analysis was repeated. In addition, while deciding on the items to be included in the created dimensions, their conceptual suitability was also evaluated together with statistical analysis.

After the trial application, the finalised "Digital Intelligence Level 1 Children's Scale" and "Digital Intelligence Level 2 Children's Scale" were applied and the validity and reliability studies were carried out with the data obtained. Before conducting confirmatory factor analysis, the assumption of multivariate normality was assessed, and when this assumption was violated, the robust maximum likelihood estimation method was employed. In the confirmatory factor analysis, χ^2/sd, CFI, NFI, NNFI and RMSEA goodness of fit indices were evaluated to assess model fit. The acceptance ranges for the fit index values used (Çokluk et al., 2010) are presented in Table 5.

Table 5. Criteria and cut-off points for acceptance of model fit indices

Compliance index	Criteria	Breakpoints for Admission	Source
χ^2/df		≤ 2 = perfect fit	(Tabaccknick & Fidell, 2001)
		≤ 2.5 = perfect fit (in small samples)	(Kline, 2023)
		≤ 3 = perfect fit (in large samples)	(Kline, 2023; Sümer, 2000)
		≤ 5 = moderate level	Sümer, 2000)
GFI/AGFI	0 (no harmony) 1 (perfect fit)	≥ 0.90 = good fit	(Schumacker & Lomax, 1996; Hooper et al., 2008; Kelloway, 1989; Sümer, 2000)
		≥ 0.95 = perfect fit	Hooper et al., 2008; Sümer, 2000)
RMSEA	0 (perfect fit) 1 (no harmony)	≤ 0.05 = perfect fit	(Brown, 2006; Jöreskog & Sörbom, 1993; Raykov & Marcoulides, 2008; Schumacker & Lomax, 1996; Sümer, 2000)
		≤ 0.06 = good fit	(Hu & Bentler, 1999; Thompson, 2004)
		≤ 0.07 = good fit	(Steigher, 2007)
		≤ 0.08 = good fit	(Hooper et al., 2008; Jöreskog & Sörbom, 1993; Sümer, 2000)
		≤ 0.10 = zayıf uyum	(Kelloway, 1989; Tabaccknick & Fidell, 2001)
CFI	0 (no harmony) 1 (perfect fit)	≥ 0.90 = good fit	(Hu & Bentler, 1999; Sümer, 2000; Tabaccknick & Fidell, 2001)
		≥ 0.95 = perfect fit	(Hu & Bentler, 1999; Sümer, 2000)
NFI/NNFI	0 (no harmony) 1 (perfect fit)	≥ 0.90 = good fit	(Kelloway, 1989; Schumacker & Lomax, 1996; Sümer, 2000; Tabaccknick & Fidell, 2001; Thompson, 2004)
		≥ 0.95 = perfect fit	(Hu & Bentler, 1999; Sümer, 2000)

For exploratory factor analysis, SPSS 25 package program was used and for confirmatory factor analysis, LISREL 8.80 program was used. For the calculation of Cronbach's alpha and McDonald's ω reliability coefficients, Jamovi 2.2.5 program was used. After the trial application, the compatibility of the scale structures revealed by EFA with the re-collected data was determined with Confirmatory Factor Analysis (CFA). In this context, Confirmatory Factor Analysis (CFA) was conducted on a separate sample to test and validate the factor structure based on theoretical expectations (Schumacker & Lomax, 2010).

While performing confirmatory factor analysis, fit indices, factor loadings, and error variances were examined to evaluate the model's fit to the data. Chi-Square CFI, TLI and RMSEA values were used to test the fit of the model to the data. If the CFI and TLI values used to evaluate the fit of the model to the data are higher than 0.95 and less than 0.08 for RMSEA, it can be stated that the model demonstrated a good fit to the data (Hu & Bentler, 1999). By computing fit indices, factor loadings (max-min), and error variances (max-min), it was concluded that the models adequately fit the data.

FINDINGS AND DISCUSSION

In this section, tables regarding construct, content validity and reliability are presented.

Findings on Validity

The indicator of whether the items forming the scale are sufficient to fulfill the feature they aim to measure is the content validity. One of the methods used to test the content validity is to seek expert opinions (Büyüköztürk, 2016, p.180). In this context, expert opinions were obtained regarding the candidate test items created. In order to determine the content validity of the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale', the opinions of one measurement and evaluation field expert, five preschool education field experts, two computer and instructional technologies field experts and one psychology field expert were consulted.

After expert opinions, the content validity index for each item was calculated using Davis and Lawshe techniques. The content validity index calculated with this technique is desired to be 0.75 for the Lawshe technique and 0.80 and higher for the Davis

technique (Yurdugül, 2005). According to the analyses, the CGI values for the 37 items constituting the 'Digital Intelligence Level 1 Children's Scale' were calculated as 0.78 with the Davis technique and 0.56 with the Lawshe technique. It was observed that 15 of the 37 items were below the CGI reference values. However, in line with expert opinions, the necessary arrangements were made in the relevant items, and the items were preserved and revised. The CGI values for the 67 items constituting the 'Digital Intelligence Level 2 Children's Scale' were calculated as 0.94 with the Davis technique and 0.88 with the Lawshe technique. It was found that 21 of the 67 items were below the reference value. However, in line with expert opinions, the items were preserved, 21 items in the 'Digital Intelligence Level 2 Children's Scale' were revised and 1 item was added to the scale.

Preliminary application analyses were performed on the data obtained from the pre-application of the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale.' According to these analyses, the corrected item-total score correlations regarding the item discrimination of the scales were calculated and presented in Table 6.

Table 6. "digital intelligence level 1 child scale" pre-test application corrected item-total correlation

Item Nu	r	Item Nu	r
1	0,42	20	0,74
2	0,44	21	0,68
3	0,49	22	0,67
4	0,53	23	0,64
5	0,36	24	0,73
6	0,49	25	0,72
7	0,57	26	0,63
8	0,64	27	0,62
9	0,54	28	0,73
10	0,48	29	0,52
11	0,40	30	0,51
12	0,37	31	0,70
13	0,12	32	0,63
14	0,21	33	0,52
15	0,17	34	0,10
16	0,67	35	0,73
17	0,68	36	0,76
18	0,77	37	0,76
19	0,72		

As shown in Table 6, the corrected item-total score correlation values ranged from 0.10 to 0.77. The corrected item-total correlations for three items were determined to be below 0.20. This may be an indication that the items did not fully measure the relevant structure. However, in line with expert opinions, it was decided to keep the items on the scale for factor analysis.

Table 7. "Digital intelligence level 2 child scale" pre-test application corrected item-total correlation

Item Nu	r	Item Nu	r	Item Nu	r	Item Nu	r
1	-0,04	19	0,44	37	0,67	55	0,69
2	0,26	20	0,64	38	0,51	56	0,72
3	0,39	21	0,69	39	0,69	57	0,73
4	0,21	22	0,81	40	0,75	58	0,70
5	0,37	23	0,81	41	0,77	59	0,69
6	0,29	24	0,61	42	0,73	60	0,67
7	0,48	25	0,60	43	0,75	61	0,63
8	0,48	26	0,59	44	0,25	62	0,72
9	0,45	27	0,62	45	0,27	63	0,73
10	0,18	28	0,53	46	0,38	64	0,73
11	0,29	29	0,62	47	0,60	65	0,71
12	0,23	30	0,71	48	0,29	66	0,65
13	0,22	31	0,68	49	0,64	67	0,73
14	0,47	32	0,65	50	0,68	68	0,68
15	0,09	33	0,72	51	0,61		
16	0,06	34	0,67	52	0,69		
17	0,07	35	0,55	53	0,66		
18	0,25	36	0,67	54	0,57		

As shown in Table 7, the corrected item-total correlation values range from -0.04 to 0.81. The corrected item-total correlations for five items were determined to be below 0.20. This may be an indication that these items did not fully measure the relevant structure. However, it was decided to keep the items on the scale for factor analysis in line with expert opinions.

Findings Related to Construct Validity and Reliability

Construct validity shows how accurately a measurement tool can measure an abstract concept (Tavşancıl, 2014). Construct validity is related to how accurately measurable and observable questions prepared to measure abstract characteristics of individuals such as attitude, motivation, performance, and ability measure the specified characteristics (Büyüköztürk, 2012). The results of exploratory and confirmatory factor analysis conducted to determine construct validity are presented below.

Before performing exploratory factor analysis on the Digital Intelligence Level 1 Child Scale consisting of 37 items, KMO (Kaiser-MEyer-Olkin) and Bartlett statistics values (KMO=0.892; Bartlett's statistic = 5337.445/sd=666/p<0.001) were determined and it was concluded that the sample size was sufficient for conducting factor analysis.

Table 8. factor load values of digital intelligence level 1 child scale items

Item Nu	Factor			
	1	2	3	4
2			,527	
3			,793	
4			,685	
5			,833	
6			,829	
7			,787	
8			,552	
11				,715
12				,610
13				,877
14				,745
16	,812			
17	,916			
18	,901			
19	,912			
20	,892			
21	,866			
22	,859			
24	,622			
25	,838			
26	,790			
27	,818			
28		,596		
29		,697		
30		,492		
33		,686		
35		,882		
36		,909		
37		,822		

Table 8 reveals that the Digital Intelligence Level 1 Child Scale consists of a four-dimensional structure. The determined four-factor structure for the Digital Intelligence Level 1 Child Scale accounted for 66.83% of the variance. In other words, 29 items explain 66.83% of the variance in the four-dimensional structure. It is observed that the Digital Intelligence Level 1 Child Scale includes 11 items within the first dimension, 7 items in the second, 7 items in the third, and 4 items in the fourth dimension. According to Costello and Osborne (2005), item factor loading values should be at least .30. Given that the factor loading for each item exceeds 0.30, it can be inferred that the items effectively represent their respective dimensions. Taking into account the semantic integrity of the items in the dimensions, the first dimension was named "Cyber Risk/Security Management", the second dimension was named "Media and Information Literacy", the third dimension was named "Digital Citizenship Identity" and the fourth dimension was named "Balanced Use of Technology".

The path diagram explaining the Digital Intelligence Level 1 Child Scale measurement model is shown in Figure 1.

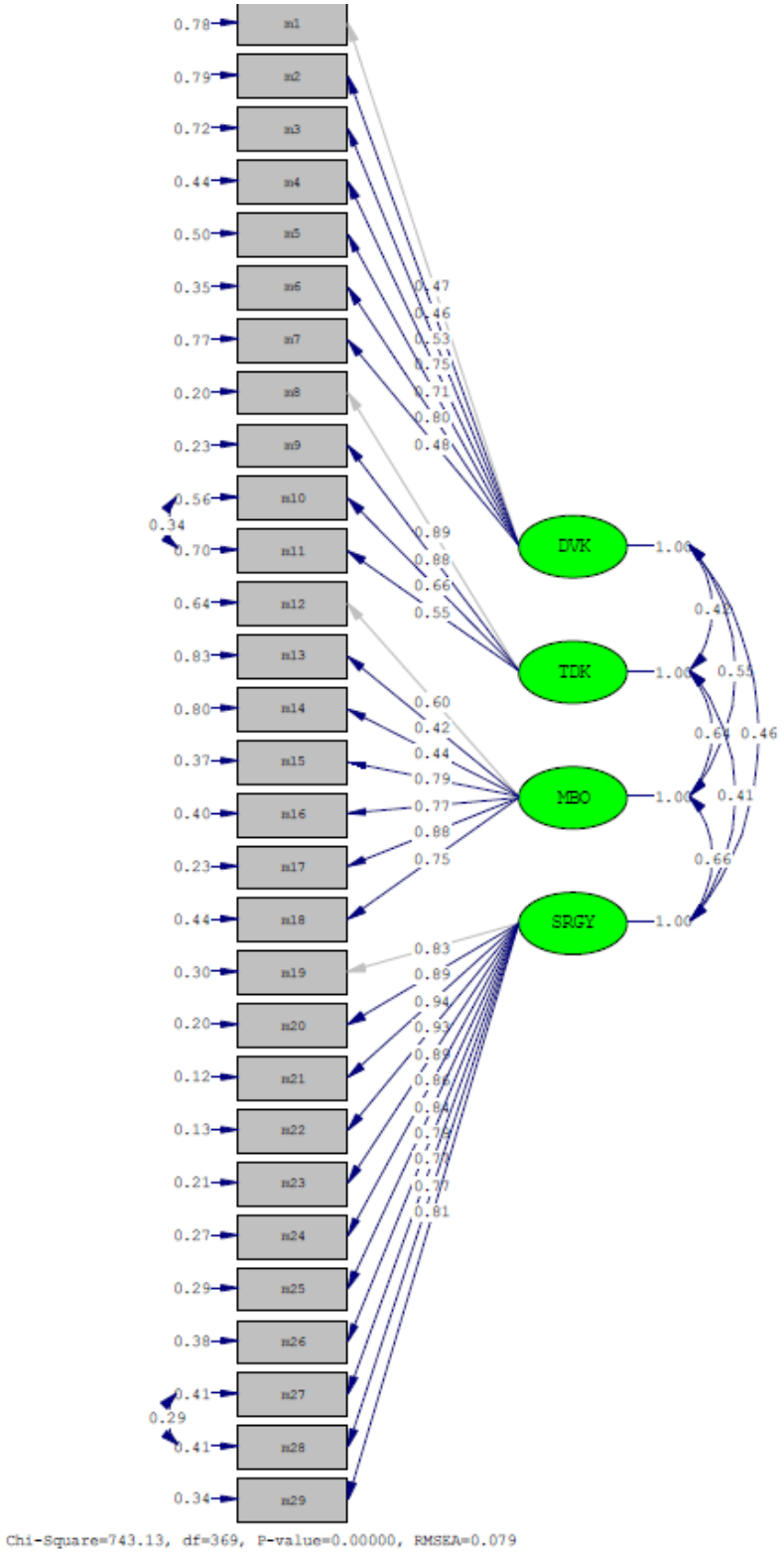


Figure 1. Digital Intelligence Level 1 Child Scale Measurement Model

Confirmatory factor analysis was conducted to verify the four-dimensional structure of the Digital Intelligence Level 1 Child Scale. In the confirmatory factor analysis, the model-data fit was assessed through examination of fit indices, factor loadings, and error variances. The values for fit indices, the range of factor loadings, and error variances are presented in Table 9.

Table 9. digital intelligence level 1 child scale confirmatory factor analysis results

	χ^2	χ^2/df	p	CFI	NFI	NNFI	RMSEA	Factor Loading Values		Error Variances	
								max	min	max	min
Scale	743,13	2,01	0,000	0,97	0,93	0,96	0,079	0,94	0,42	0,83	0,12
Proposed Value		$\chi 2/df \leq 3$		≥0,90	≥0,90	≥0,90	≤0,080	≥0,30		≤0,90	

According to the data presented in Table 9, it is observed that the χ^2/df value is less than 3, indicating that the model fits the data very well (Kline, 2005). The CFI value was found to be 0.97 and the NFI value was found to be 0.93 and these values being above 0.90 are accepted as an indicator that the model has an acceptable degree of fit to the data (Byrne, 2010). The RMSEA index was calculated as 0.079, which indicates an acceptable level of model fit. There are 67 items in the Digital Intelligence Level 2 Child Scale. Before conducting exploratory factor analysis, KMO (Kaiser-Meyer-Olkin) and Bartlett statistics values (KMO=0.942; Bartlett's statistic = 19291.494/sd=2278/p<0.001) were determined and it was concluded that the sample size was adequate for conducting factor analysis.

Table 10. factor loading values of digital intelligence level 2 child scale items

Item nu	Factor						
	1	2	3	4	5	6	7
4							,691
6							,831
7							,771
8							,585
9							,567
12				,625			
13				,805			
14				,755			
15				,724			
16				,782			
18				,584			
20	,746						
21	,899						
22	,953						
23	,864						
24	,904						
25	,875						
26	,830						
27	,677						
29	,664						
30	,613						
33	,632						
37						,462	
38						,791	
39						,789	
40						,784	
41						,775	
44					,462		
49					,918		
50					,905		
51					,787		
55			,935				
56			,968				
57			,958				
58			,864				
59			,894				
61		,601					
62		,820					
63		,839					
64		,873					
65		,936					
66		,945					
67		,797					
68		,836					

Table 10 reveals that the Digital Intelligence Level 2 Child Scale consists of a seven-dimensional structure. The seven-factor structure identified for the Digital Intelligence Level 2 Child Scale explained a total variance of 71.46%. The scale comprises 11 items in the first dimension, 8 items in the second, 5 items in the third, 6 items in the fourth, 4 items in the fifth, 5 items in the sixth, and 5 items in the seventh dimension. According to Costello and Osborne (2005), item factor loading values should be at least .30. As each item exhibits a factor loading exceeding 0.30, it can be asserted that the items adequately represent their respective dimensions. Taking into account the semantic integrity of the items in the dimensions, the first dimension was named "Cyber Risk/Security Management", the second dimension "Digital Empathy", the third dimension "Digital Footprint Management", the fourth dimension "Balanced Use of Technology", the fifth dimension "Media and Information Literacy", the sixth dimension "Privacy Management" and the seventh dimension "Digital Citizen Identity".

The path diagram explaining the Digital Intelligence Level 2 Child Scale measurement model is shown in Figure 2.

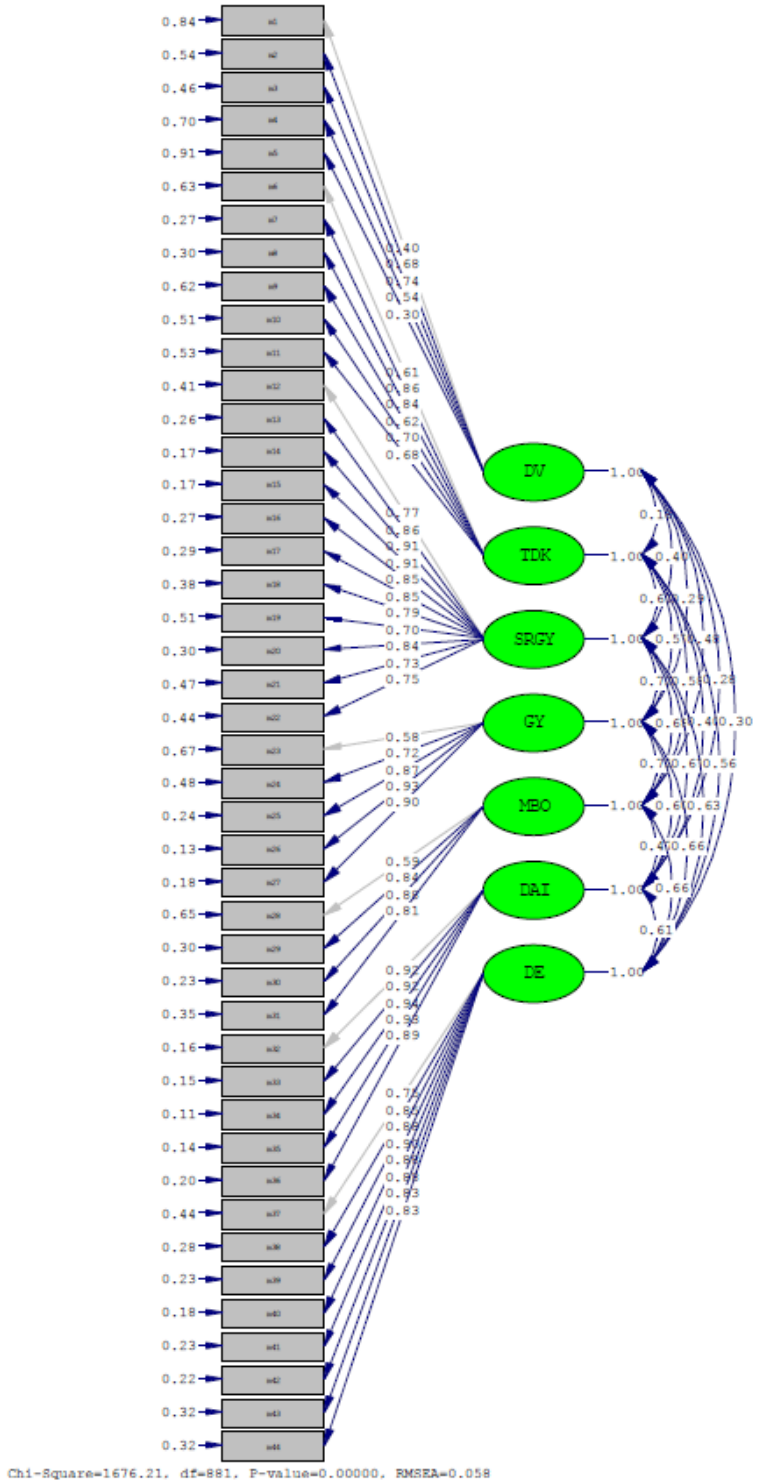


Figure 2. Digital Intelligence Level 2 Child Scale Measurement Model

Confirmatory factor analysis was conducted to verify the seven-dimensional structure of the Digital Intelligence Level 2 Child Scale. In the confirmatory factor analysis, model-data fit was assessed by examining fit indices, factor loadings, and error variances. Table 11 presents the fit index values, the range of factor loadings, and the range of error variances.

Table 11. Digital intelligence level 2 child scale confirmatory factor analysis results

	χ^2	χ^2/df	p	CFI	NFI	NNFI	RMSEA	Factor Loadings		Error Variances	
								max	min	max	min
Scale	1676,21	1,90	0,000	0,98	0,97	0,98	0,058	0,94	0,30	0,91	0,11
Proposed Value		χ2/df ≤ 3		≥0,90	≥0,90	≥0,90	≤0,080	≥0,30		≤0,90	

An examination of Table 11 reveals that the χ^2/df value is below 3, suggesting a good fit of the model to the data. The CFI was calculated as 0.98, the NFI as 0.97, and the NNFI as 0.98. The fact that these values exceed 0.90 indicates that the model demonstrates a very good fit to the data. When evaluated in terms of the RMSEA index, the value for the model was found to be 0.058, indicating an acceptable level of model fit.

Findings on Reliability

Cronbach's alpha and McDonald's ω coefficients were calculated to assess the internal consistency of the Digital Intelligence Level 1 Child Scale scores. The results are presented in Table 12.

Table 12. examining the reliability of digital ıntelligence level 1 child scale scores

	Number of Items	Cronbach's Alpha	McDonald's ω
Cyber Risk/Security Management Dimension	11	0,96	0,96
Media and Information Literacy Dimension	7	0,89	0,90
Digital Citizenship Identity Dimension	7	0,86	0,86
Balanced Use of Technology Dimension	4	0,81	0,82
Digital Intelligence Level 1 Child Scale	29	0,94	0,94

In assessing the range of reliability coefficients, values below 0.50 are interpreted as low, those between 0.50 and 0.80 as moderate, and values exceeding 0.80 as high (Salvucci, Walter, Conley, Fink, & Saba, 1997, p.115). As seen in Table 12, the Cronbach's alpha value calculated for the entire Digital Intelligence Level 1 Child Scale was found to be 0.94. The McDonald's ω value calculated for the entire Digital Intelligence Level 1 Child Scale was found to be 0.94. Since the calculated reliability coefficients exceed 0.80, it can be concluded that the scale scores demonstrate acceptable reliability.

Cronbach's alpha and McDonald's ω coefficients, as measures of internal consistency reliability for the Digital Intelligence Level 1 Child Scale scores, were calculated. The results are presented in Table 13.

Table 13. examining the reliability of digital intelligence level 2 child scale scores

	Number of Items	Cronbach's Alpha	McDonald's ω
Cyber Risk/Security Management Dimension	11	0,95	0,95
Digital Empathy Dimension	8	0,96	0,96
Digital Footprint Management Dimension	5	0,98	0,98
Balanced Use of Technology Dimension	6	0,81	0,82
Media and Information Literacy Dimension	4	0,86	0,87
Privacy Management Dimension	5	0,91	0,92
Digital Citizenship Identity Dimension	5	0,75	0,76
Digital Intelligence Level 2 Child Scale	44	0,96	0,96

As seen in Table 13, Cronbach alpha value calculated for the entire Digital Intelligence Level 2 Child Scale was found to be 0.96. The McDonald's ω value calculated for the entire Digital Intelligence Level 2 Child Scale was found to be 0.96. Since the calculated reliability coefficients exceeded 0.80, it can be concluded that the scale scores demonstrate satisfactory reliability.

CONCLUSION AND SUGGESTIONS

The research aimed to conduct a validity and reliability study of the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale' developed to assess the digital intelligence levels of children. For this purpose, parents of children attending public or private kindergartens/preschools affiliated to the Ministry of National Education and first and second grades of

primary schools in the central districts of Ankara province in the 2021-2022 and 2022-2023 academic years provided the data for the study. According to the validity and reliability findings of the statistical analyzes of the obtained data, the 'Digital Intelligence Level 1 Child Scale' consisting of 29 items in 4 dimensions and 'the 'Digital Intelligence Level 2 Child Scale' consisting of 44 items in 7 dimensions were accepted as valid and reliable assessment tools."

This measurement tool is important because the concept of Digital Intelligence has not yet been defined in the literature and the number of studies conducted on this topic is limited. A similar study specifically addressing the measurement and assessment of digital intelligence in children is the development of a digital intelligence scale for elementary school children in China (Li et al., 2024). The study confirmed high reliability and validity as a 22-item structure consisting of seven dimensions. While the number and scope of dimensions are the same as the Digital Intelligence Level 2 scale, a digital intelligence scale with fewer items was developed for literate children. The methodology and data analysis processes of the study conducted in China in 2024 are similar to this study.

In addition, the fact that this study is a scale assessing the digital intelligence of illiterate children demonstrates its originality. In light of the data obtained from this research, the following recommendations are presented: In the light of the data obtained from the research, the following suggestions are presented;

- Data for the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale' were provided by parents. Forms of data obtained from teachers and children can also be created. Data obtained from parents, teachers and children can be determined correlationally.
- A norm study can be planned for a wider Turkey sample for the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale'.
- Longitudinal studies can be conducted to see the long-term effects of the 'Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale'.
- Digital Intelligence Level 1 Child Scale' and 'Digital Intelligence Level 2 Child Scale' can provide a step for new measurement tools to be developed for the assessment of digital intelligence.

Ethics and Consent: Ethical approval for this study was granted by the Gazi University Ethics Commission during its meeting held on 22 March 2022 (approval number: 06), with a unanimous decision indicating that no ethical concerns were identified.

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