



## Research Paper: Normative Study and Psychometric Properties of the Digital Quotient Test in Children and Adolescents Aged 8-18 in the Iranian Community



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### Abstract

**Objective:** Digital Quotient (DQ) refers to a comprehensive set of digital competencies derived from universal ethical values that aim to enhance human interaction with, controlling, and creating technology. The present study aimed to establish norms and examine the psychometric properties of the Digital Quotient Test in children and adolescents aged 8-18 in the Iranian community.

**Methods:** This study's population included students of the First and Second Elementary Schools and Tehran's First and Second Secondary Schools in the academic year 2020-2021. A total of 521 students (277 girls and 244 boys) were examined using a convenience sampling method. To analyze the data obtained from the test, inferential statistics were employed to determine construct validity, Pearson correlation matrix and test-retest reliability using SPSS software version 26.

**Results:** The results indicated that the construct validity of the Digital Quotient Test, using the internal consistency between its eight domains and the total score as evidence for this validity, was appropriate ( $P < 0.05$ ). Using the test-retest method with a coefficient of 0.872, the test reliability was estimated to be relevant, too ( $P < 0.01$ ).

**Conclusion:** The Digital Quotient Test has appropriate validity and reliability in children and adolescents aged 8-18 years in the Iranian community.

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## 1. Introduction

Humankind has experienced three industrial revolutions and is going through the fourth industrial revolution. These industrial revolutions have required specific skills and competencies (Marnewick & Marnewick, 2021). The first industrial revolution demanded physical skills and the use of industrial machinery (Drath & Horsch, 2014); the second industrial revolution required cognitive skills with a focus on mass production (Liu & Grusky, 2013); the third industrial revolution emphasized the soft skills with a focus on emotional intelligence (Maqbool et al., 2017); and the fourth industrial revolution emphasizes the mastery of digital skills (Park, 2019). The fourth industrial revolution and rapid technological changes have created a gap between existing capabilities and the competencies required for various roles (Whysall et al., 2019). This revolution has led to fundamental changes in how we live, work, and interact with others, necessitating a new type of intelligence to face these profound changes. This new type of intelligence requires new competencies (Marnewick & Marnewick, 2021). The foundational skills for transitioning from physical, cognitive, and emotional skills to digital skills require an intelligence known as digital quotient (Marnewick & Marnewick, 2021).

The Digital Quotient enables individuals to interact successfully within the digital ecosystem and solve necessary issues in virtual environments (Adams, 2004). The International Society for Digital Quotient defines Digital Quotient as a comprehensive

set of digital competencies derived from universal ethical values, which aim to enhance human interaction with, control over, and creation of technology (Park, 2019). This definition has two important aspects. First, an individual's digital skills and competencies should originate from ethical values. The second is that technology should be used to advance human progress, not to harm people and societies. NA-Nan et al. (2019) defines digital competencies as technical, cognitive, social, and emotional skills that enable individuals to face challenges and adapt to digital environments. This definition emphasizes not only technology but also the use of cognitive, social, and emotional competencies in dealing with the consequences and effects of technology. This aligns with Hirsch et al. (2019) definition, which still considers cognitive and soft skills important. According to Mithas and McFarline (2017), Digital Quotient involves aligning business strategies with information technology. This advantage encourages project managers to enhance their Digital Quotient skills. Cismaru et al. (2018) define Digital Quotient as the skill to understand and adapt to using digital/online concepts to solve online communication, information, and technological problems. This definition differs from others by focusing solely on online problem-solving, overlooking that technology can also be used in offline environments and human-tool interactions (Marnewick & Marnewick, 2021).

The Provincial Government of British Columbia, Canada, defines digital literacy as individuals' interest, attitude, and ability to

appropriately use digital technologies and communication tools to access, manage, integrate, analyze, and evaluate information, create new knowledge, and communicate and interact with others. This framework includes six characteristics of digital literacy: 1) information and research literacy; 2) critical thinking, problem-solving, and decision-making; 3) creativity and innovation; 4) digital citizenship; 5) communication and collaboration; and 6) technology use and related concepts (Ministry of Education of British Columbia, 2017). The Joint Research Center of the European Union has introduced the concept of a digital competency framework for citizens. The initial study of this framework began in 2005 and has been updated several times. This framework identifies 21 types of digital competencies in five areas: 1) information and data literacy, 2) communication and collaboration, 3) digital content creation, 4) safety, and 5) problem-solving.

In addition to the previous two frameworks, the Digital Quotient Society highlights a new type of intelligence called Digital Quotient (DQ). According to Park (2019), the founder of the Digital Quotient Society, digital intelligence encompasses eight domains: 1) digital identity; 2) digital use; 3) digital safety; 4) digital security; 5) digital emotional intelligence; 6) digital communication; 7) digital literacy; and 8) digital rights. The digital literacy framework in Indonesia underlines three aspects: protection, rights, and empowerment. The protection aspect includes protecting personal information, online security, and privacy. The rights aspect covers freedom of

expression, intellectual property, and social activity. The empowerment aspect involves citizen journalism and ethical information principles. Each framework has unique characteristics, but all emphasize the competencies required for individuals to live successfully in the digital age (Taufigur et al., 2021). Table 1 shows the eight domains of Digital Quotient introduced by the Digital Quotient Society (2019) and the Institute of Electrical and Electronics Engineers ([IEEE], 2020).

One of the tools introduced for assessing Digital Quotient is the Digital Quotient (DQ) test, presented by the International Society for Digital Quotient based on the criteria of its revised version in 2018 (Park, 2019). The DQ test includes a set of cognitive, emotional, and social capabilities that enable individuals to become digital citizens who face challenges and adapt to the needs of life in the digital age. This test covers eight main domains: digital citizen identity, balanced use of technology, cyber risk management, cybersecurity management, digital empathy, digital footprint management, media, information literacy, and privacy management.

Na-Nan et al. (2020) examine the validation of the Digital Quotient Test using exploratory and confirmatory factor analysis on a sample group of employees from small and medium-sized enterprises in Thailand. The study is conducted in two phases. Initially, 33 questions are developed based on existing concepts and theoretical foundations in Digital Quotient. The questions are divided into eight dimensions using exploratory

factor analysis: digital identity, digital consumption, digital security, digital safety, digital emotional intelligence, digital communications, digital literacy, and digital rights. In the field survey, 409 questionnaires were administered. In the second phase, exploratory factor analysis and convergent validity were tested for the eight dimensions. The results indicate that the concept of Digital Quotient is derived from theoretical foundations, and the resulting questionnaire is usable for measuring this concept.

[Kulworatite et al. \(2021\)](#) aim to develop an internet risk assessment tool using the Digital Quotient Questionnaire and a communication-based model on a sample group of 400 individuals aged 18-36 years. They introduce seven components using exploratory factor analysis: digital identity, digital safety, digital emotional intelligence, digital rights, digital fear, digital greed, and irrational digital decision-making. In this study, the content validity of the questionnaire is reported as 0.85, and the reliability of the questionnaire using Cronbach's alpha is reported as 0.88.

[Manakul and Tuamsuk \(2021\)](#) conduct a meta-analysis to review the literature on Digital Quotient in educational environments. The analyzed documents are from international databases published in the past ten years. Twenty-three documents are reviewed, including 15 reports, nine research articles, and six scientific-educational articles. The research tool recorded qualitative information from the integration of the documents. The meta-analysis results indicate that the most important components of digital intelligence in educational

environments are digital literacy, digital technology consumption, digital communications, and digital safety or risk management.

The expansion of digital technologies in social, economic, and personal life considers acquiring digital information skills as an important factor in individual success in social and civic life ([Ertl, Sandy et al., 2020](#); [Facer & Furlong, 2010](#); [Van Deursen & Van Dijk, 2016](#)). In today's information society, searching, evaluating, and processing information are important parts of daily life. The emergence of more advanced digital applications in the future highlights the necessity of acquiring digital information skills even further ([Van Dijk, 2020](#)). According to [Castells \(2010, as cited in Marnewick et al., 2021\)](#), informatization is observable in all professions, referring to information as the main source of productivity in many fields. The necessity of acquiring digital information skills as core competencies is particularly evident in professions in which the fundamental tasks involve searching, evaluating, and sharing information. [Claro et al. \(2018\)](#) found that only a minority of teachers can provide necessary guidance in solving digital information and communication issues for students, and the majority of teachers are reluctant to play a mediating role in students' issues related to virtual environments. Different attitudes among teachers in using information and communication technologies in education result in differences in the use of digital tools in schools, which are predictors of students' digital skills and, subsequently, differences in

students' digital capabilities (Lorenz et al., 2019). Given the necessity of assessing various domains of digital intelligence and determining educational programs related to enhancing these domains in students, the present study seeks to answer this question: Does the psychometric properties of the Digital Quotient test in children and adolescents aged 8-18 in the Iranian community have significant validity and reliability?

## 2. Methods

### 2.1. Research Design, Statistical Population, Sample, and Sampling Method

This study was applied in terms of purpose and in terms of implementation method was a descriptive survey type. The population of this study includes students aged 8-18 years of the First and Second Elementary Schools, the First Secondary School, and the Second Secondary School (1-12 grades) in Tehran during the 2020-2021 academic year. According to official statistics from the Ministry of Education in Tehran, 1.5 million students were enrolled during the 2020-2021 academic year. Cochran's formula for an unknown population was used to determine the sample size. Based on this formula, the minimum sample size was estimated to be 384 participants. The sampling method was convenience sampling, and due to the COVID-19 pandemic and the lack of in-person access to students, the test was administered electronically. After administering the test and excluding

unsuitable responses for statistical analysis, 521 responses were used as the research sample. Thus, 521 students aged 8-18 years (277 girls and 244 boys) were studied.

### 2.1. Instruments

**Digital Quotient (DQ) Test:** The Digital Quotient test was developed by the International Society for Digital Quotient based on the criteria of its revised version in 2018. This test includes eight subscales: digital citizen identity, balanced use of technology, cyber risk management, cybersecurity management, digital empathy, digital footprint management, media and information literacy, and privacy management. The test contains 53 questions (excluding demographic questions) with various scoring methods, including dichotomous, multichotomous, 5-point Likert, and 7-point Likert scales. In the study by Kulworatite et al. (2021), the content validity index of the questionnaire was reported as 0.85, and the reliability was reported as 0.88 using Cronbach's alpha. In this study, an initial translation of the test was carried out after obtaining permission from the International Society for Digital Quotient and its specialized team to use and standardize the tool for the Iranian community. The initial translation was then back-translated into English. Two experts carried out the back-translation, and after preparing the electronic version, the author provided the participants with it. Table 1 reports the sample description based on the questionnaire domains and the total score.

Table 1

*Description of the Sample Based on Questionnaire Domains and Total Score*

Variable	Minimum	Maximum	Mean	Question Number
Digital Citizen Identity	0	4	3.49	40
Balanced Use of Technology	16	55	35.86	3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-52
Cyber Risk Behavior Management	8	36	26.55	43-44-45-46-49-50-51-54-55
Personal Cybersecurity Management	19	50	36.64	27-28-29-30-31-34-35-36-37-38-39-42
Digital Empathy	0	15	7.04	41-47-48
Digital Footprint Management	1	7	2.9	22-23
Media and Information Literacy	0	8	4.52	25-26-53
Privacy Management	0	9	7.07	24-32-33
Total Scale Score	78	160	127.136	Total questions

### 3. Results

In this study, descriptive statistics were used to obtain frequency, percentage, mean, and standard deviation, and inferential statistics were used to determine construct validity, Pearson correlation matrix, and test-retest reliability using SPSS software version 26. The mean and standard deviation of the students' ages were 13.77 and 3.188 years, respectively. The distribution of the sample by educational level was as follows: 1% first

grade, 2.3% second grade, 9% third grade, 8.1% fourth grade, 10.4% fifth grade, 13.4% sixth grade, 7.7% seventh grade, 7.1% eighth grade, 4.8% ninth grade, 10.7% tenth grade, 16.5% eleventh grade, and 9% twelfth grade.

To examine the construct validity of the Digital Intelligence Test, the internal correlations between the eight domains of this test and the total score were used as evidence of this validity.

Table 2

*Internal Correlations Between the Subscales of the Test and the Total Score*

	Balanced Use	Cyber Risk Management	Cybersecurity Management	Digital Empathy	Digital Footprint	Media Literacy	Privacy Management	Total
Digital Citizen Identity	0.269	0.365	0.221	-0.108	-0.093	0.145	0.269	0.412
Balanced Use of Technology	0.0001	0.0001	0.0001	0.013	0.033	0.001	0.0001	0.0001
Cyber Risk Behavior Management	-	0.048	0.216	-0.061	0.105	0.293	0.181	0.629
Personal Cybersecurity Management	-	0.270	0.0001	0.166	0.017	0.0001	0.0001	0.0001
Digital Empathy	-	-	0.329	0.024	-0.121	0.312	0.379	0.560
Digital Footprint	-	0.0001	0.0001	0.589	0.0001	0.0001	0.0001	0.0001
Media and Information Literacy	-	-	-	0.054	0.121	0.274	0.464	0.759
Privacy Management	-	-	-	0.219	0.006	0.0001	0.0001	0.0001
	-	-	-	-	0.080	0.035	0.040	0.198
	-	-	-	-	0.067	0.423	0.365	0.0001
	-	-	-	-	-	0.192	0.013	0.214
	-	-	-	-	-	0.0001	0.773	0.0001
	-	-	-	-	-	-	0.215	0.517
	-	-	-	-	-	-	0.0001	0.0001
	-	-	-	-	-	-	-	0.585
	-	-	-	-	-	-	-	0.0001

Table 2 showed the pairwise correlations of the subscales with each other and with the total score. The significance level of each correlation coefficient is reported below that. Based on the results in Table 2, significant relationships were found between the subscales, and the correlation between the subscales and the total score was more significant than the pairwise correlations

between the subscales of this pattern is evidence of construct validity.

To examine the reliability of the Digital Intelligence Questionnaire, the test-retest method was used. Thirty students completed the test again after three weeks. The Pearson correlation coefficient between the two administrations is calculated and reported in Table 3.

Table 3  
Reliability of the Digital Intelligence Test

	Variable	Pearson Correlation Coefficient Between Two Administrations
1	Digital Citizen Identity	0.525 0.002
2	Balanced Use of Technology	0.680 0.0001
3	Cyber Risk Behavior Management	0.614 0.0001
4	Personal Cybersecurity Management	0.538 0.002
5	Digital Empathy	0.538 0.002
6	Digital Footprint Management	0.587 0.001
7	Media and Information Literacy	0.567 0.001
8	Privacy Management	0.625 0.0001
9	Total Score	0.872 0.0001

Table 3 showed that the correlation coefficients between the two administrations at the 99% level in subscales and total score are significant. It can be concluded that the Digital Intelligence Test has appropriate test-retest reliability, with the coefficient for the total score being 0.872.

#### 4. Discussion

The present study aimed to establish normative data and examine the psychometric properties of the Digital Quotient Test in Iranian children and adolescents aged 8 to 18. To assess the construct validity of the Digital Quotient Test, the internal correlations between the

eight domains of this test and the total score were used as evidence for this validity. The results indicated that the test has appropriate construct validity. The test-retest method was employed to examine the reliability of the Digital Quotient Test. The results showed that the Digital Quotient Test has appropriate test-retest reliability, with a coefficient of 0.872 for the total score. The results of the present study were consistent with the studies conducted by Na-Nan et al. (2020), Kulworatit et al. (2021), and Manakul and Tuamsuk (2021).

According to Van Laar, et al (2020b), a digital appendix is needed for each of the

21st-century skills, including technical, communication, collaboration, critical thinking, creativity, and problem-solving skills. For example, digital communication skills include transferring information online through social media, email, and online chat. Digital information retrieval skills include searching for information from digital sources and evaluating the usefulness and credibility of the received information. Van Laar et al. (2020a) emphasized that digital skills have a sequential and conditional nature, meaning they build upon one another. There is a significant gap between the skills students acquire through formal education and the skills needed for living and working in the 21st century (Lau & Yuen, 2014). Formal education has not been sufficient in enhancing students' competencies, indicating a need for preparedness, skillfulness, and progress toward enhancing digital competencies (Hatlevik & Hatlevik, 2018). Therefore, an assessment tool for such digital competencies to develop necessary educational programs suited to the context of the Iranian community appears essential.

One limitation of the present study is the data collection method, conducted electronically due to the COVID-19 pandemic. To enable comparative studies, it is suggested that the test be normed in cities other than Tehran. This research was conducted on students in Tehran. It is suggested that such a study be carried out on the students of other cities as well.

## 5. Conclusion

The findings showed that the Digital Quotient Test has appropriate construct validity and appropriate test-retest reliability in children and adolescents aged 8-18 in the Iranian community. Therefore, In the digital age, there is a need for preparedness, skillfulness, and the movement toward enhancing digital politics.

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## Conflict of Interest

The Authors declare that there is no conflict of interest with any organization. Also, this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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