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Digital competency factor analysis among the digital native generation

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ABSTRACT

The purpose of this study is to develop and analyze the feasibility of a digital competency measurement tool suitable for the digital native generation. The study was conducted among 394 four-year college students of E University located in Gyeonggi-do. As for the research method, the factors composing digital competency were synthesized through a literature review on the constituent factors of digital competency. The sub-measurement items were developed focusing on the constituent factors of digital competency derived through literature review. As for the data collection method, an online survey webpage was opened, and an e-mail was sent to the participating students so that they could participate in the survey. The collected data were analyzed using the PASW Statistics 18.0 program. First, a frequency analysis was conducted to examine the demographic and sociological factors of the subjects. Furthermore, to find out the digital competency level of university students, the digital native generation, the average value was calculated with descriptive statistics. In addition, factor analysis was performed to analyze the convergent validity of detailed indicators of each area of the digital competency measurement tool. As a result of measuring the digital competency of the students participating in the test, the level of digital competency perceived by the students was found to be generally high, and in particular, the overall average of the sub-factors in the application area showed a high average value for all three sub-factors. Also, as a result of analyzing the validity of the digital competency components, the overall explanatory variance of the 54 component models developed in this study was high.

1. Introduction

The OECD has emphasized that ICT (Information and Communications Technology) skills will become essential skills along with reading, writing, and arithmetic in the 21st century (Ananiadoui and Claro, 2009; OECD, 2016). The UN has also proposed that digital competency should be included as a core competency required for learners in the future society (Bocconi et al., 2016). Major countries in the world are striving to take the lead in key digital technologies centered on artificial intelligence, and are pushing forward with national efforts to solve their own issues and problems through technological development. These social changes and demands are also reflected in education policy. Several European countries, such as Denmark and France, recognize and practice the importance of digital literacy education (Bocconi et al., 2016), and the UK also emphasizes computational thinking through computing subjects (Sung and Kim, 2015). In the United States, computer education is being implemented by announcing the 2016 computer science curriculum expansion plan (Computer science for all) and the national R&D (Research and development) strategy for artificial intelligence (NSTC, 2016). Based on the compulsory education and the 2019 AI (Artificial intelligence) national strategy, policy measures for AI education for all people are being prepared and curriculum development is being promoted (MOE, 2015).

Digital competency is a concept in which general competencies such as communication ability, collaboration ability, and problem-solving ability are integrated with knowledge, skills, and attitudes about the Internet, ICT, media, and information (Ala-Mutka, 2011). Cartelli et al. (2010) suggested multidimensionality, measurability, continuity, integration, and contextuality as characteristics of digital competency. In addition, the level of digital

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competence varies according to individual abilities and characteristics, which is presented as a digital taxonomy divided into memory, understanding, application, analysis, evaluation, and creation (Vardhan, 2019; Krathwohl, 2002; Lee and Kim, 2021; Munzenmaier and Rubin, 2013; Park, 2021).

Digital competency has been suggested as a factor that promotes problem-solving ability, interpersonal relationship ability, and communication ability in several previous studies. Van Puijenbroek et al. (2014) found that the more employees use social media in job situations, the more they form a culture of critical thinking and inquiry, and the higher their ability to solve job-related problems. Oguz et al. (2010) stated that in the digital age, online interaction using the Internet web and social network services not only enhances collaboration among organizational members but also promotes knowledge sharing, diffusion, and creation. Janssen et al. (2009) stated that online team activity among organizational members promotes social and empathy, enhances interpersonal relationships, and strengthens mutual critical feedback and positive collaboration.

Digital competencies show differences in abilities according to individuals, and tools to evaluate the level are being developed (Koc and Barut, 2016; Ozdamar-Keskin et al., 2015). The characteristics of the digital competency diagnosis tool explored in this study are as follows.

First, Ferrari (2013) developed a diagnostic tool to measure the level of digital competency development of European citizens. It consists of diagnosing basic, intermediate, and advanced communication and collaboration skills in learning and employment situations, the ability to create digital content, and problem-solving skills through digital tools and resources. Ozdamar-Keskin et al. (2015) developed a digital literacy competency diagnostic tool to use a digital technology platform for learning and to identify problem-solving and creative abilities based on the digital technology platform for Turkish university students conducting distance education. Although this has an advantage in measuring digital competency in a learning situation considering university students, its limitation does not consider digital information management aspects such as information selection, analysis, and synthesis. In addition, since it is limited to specific digital tools and platforms such as Google Docs, it is necessary to reconfigure it to fit the tools or platforms used in Korea. In other words, a valid test tool for diagnosing digital competency is needed.

Therefore, in this study, we intend to develop a digital competency measurement tool suitable for college students, who are the digital native generation and analyze its feasibility. The analysis results are first used as basic data for the online learning environment design and educational content development based on the digital competency diagnosis results. Second, it is intended to be used as basic data for the development of educational programs to enhance digital competency. The problems of this study according to the purpose are as follows:

- First, what is the digital competency level of college students?
- Second, what is the validity of the digital competency components of college students?

2. Prior research on digital competency

The modern society we live in is a knowledge information society in which advanced knowledge and information technologies such as artificial intelligence, the Internet of things, and big data combine with existing industries to form a new industrial structure. The spread of smart devices has created a digital environment and required nurturing talents who can respond flexibly in a diversified society. As such, among the competencies required for talents in the knowledge and information society, digital competencies are being emphasized. Securing digital capabilities is important as well as checking the current infrastructure of Korea as it is expected that the presence or absence of market-leading advanced technology will determine the success or failure of individuals and nations in the future (Lee and Lee, 2022). Since 2018, Korea has implemented digital competency cultivating classes such as 'Computing Thinking Skills' in regular elementary and secondary education courses. Steve Jobs emphasized the importance of digital education when he said, 'Coding teaches you how to think.'

Digital competence goes beyond the simple use of digital technology and is related to an individual's cognitive, affective, and social abilities, and can be said to be a concept that can measure the level. In a study by Cartelli et al. (2010), digital competency is viewed as a concept in which two aspects are linked. The first includes the use of computers for leisure, information sharing, collaborative networking, learning and research in everyday contexts, the healthy use of the Internet, and communication through electronic media. The second includes support for creativity and innovation, etc., an understanding of whether the information is valid, reliable, and appropriate, and knowledge of ethical principles for the use of technology. In the study of Ilomäki et al. (2011), digital competency is related to the critical use of information society technology for work and leisure and communication, dissemination, evaluation, storage, production, expression, and exchange of information, and communication and it is defined as the use of ICT to participate in cooperative networks. Ala-Mutka (2011) stated that digital competence is related to the confident and critical use of information society technologies for work, life, and communication. It emphasizes the basic ICT competencies required to build and participate in Internet-based networks for dissemination, evaluation, storage, production, expression, and exchange of information. Ferrari (2012) described digital competency as performing

tasks, solving problems, communicating, managing information, collaborating, creating, and sharing content, in work, leisure, participation, learning, social activities, and consumption activities. It is defined as the knowledge skills, and attitudes necessary to use ICT and digital media to construct knowledge critically and creatively. As such, the definition of digital competency is different for each researcher. However, if defined comprehensively, digital competence can be said to be the ability to solve problems in work and learning situations using digital tools and information and to share, produce and express knowledge and information by participating in an online community.

Looking at the previous studies, digital competency research has been conducted focusing on the term digital literacy and ICT application ability. Gilster (1997) and Bawden (2008) defined digital literacy as the ability to understand and use information from a variety of digital sources. In other words, digital literacy is the ability required for modern people to access information, critically analyze and utilize information, and produce information due to the diversified and complex use of digital media. Digital competency is a concept that describes technology-related competency. In the European Commission research report in 2016, DigComp (Digital Competence) 2.0, which consists of five areas: Information and data literacy, communication and collaboration, digital content creation, security, and problem-solving, was announced (Tohara, 2021). Digital competency is the knowledge, skills, and attitudes necessary to perform tasks, problem-solving, communication, information management, collaboration, content creation and sharing, and knowledge building using ICT and digital effectively and efficiently after media. These include capabilities, strategies, values, and perceptions. Choi (2018a) compared domestic and foreign digital literacy-related studies with the competencies required in the era of the 4th industrial revolution. Building on this, she described digital competency as "the ability for each member of a digital society to live, learn, and perform innovative and creative tasks in their respective fields, including knowledge, attitudes, skills and It includes thinking skills to solve problems." In order to explore the concept of digital competency, an understanding of literacy is required. The concept of literacy has been expanded from simply the ability to read and write something to the dimension of creation and utilization (Kim, 2019). Digital competency is a concept that includes a similar concept of digital literacy (Gallardo-Echenique et al., 2015; Hatlevik and Christophersen, 2013). Digital literacy refers to an individual's cognitive, social, and emotional skills necessary to understand, produce, and exchange the meaning of digital resources composed of text, images, and audio. On the other hand, digital competency is the ability necessary to improve learning or organizational performance in work, life, and education based on the meaning interpretation and utilization of digital resources.

As interest in digital competency increases, related research is also continuously increasing. However, research on the development of diagnostic tools to measure digital competence is quantitatively insufficient. In addition, as the digital-based knowledge and information society rapidly develops and changes, standards are constantly updated. There is a part where the measurement standards of previous studies are somewhat inappropriate in that they should development is needed.

The components of digital competency can be confirmed through research that analyzes digital competency by dividing it into detailed areas and research that develops a digital competency measurement tool. Ferrari (2012), presented a comprehensive concept of digital competency including not only the use of digital devices but also high-order thinking skills in seven areas (Ferrari et al., 2012). The first is 'information management,' which includes identification, location, access, retrieval, storage, and organization of information. Second, it is 'cooperation,' where one engages in online networks and communities to interact constructively with others. Third, it is 'communication and sharing' based on correct online behavior such as the protection of personal information and safety. Fourth, it is 'creating new content and knowledge' through the integration and reconstruction of existing content and knowledge. Fifth, it includes 'ethical awareness and responsibility.' Sixth, it is 'evaluation and problem solving' that identifies digital information, evaluates retrieved information, and solves problems in a digital way. Seventh, it is 'technology management' that uses digital technology and digital media to perform work (Abad-Segura et al., 2020). The European Commission Joint Research Center in 2016 presented the DigComp (Digital Competence) 2.0 framework. It was divided into five areas: Information and data utilization ability, communication and collaboration, digital content production, safety, and problem solving. Abad-Segura et al. (2020) derived digital competency by considering the background aspect of digital competency. Based on this, six digital competency areas were presented: digital device literacy, digital content literacy, digital communication and cooperation, digital citizenship, digital problem solving, and digital vocational literacy. Calvani et al. (2008) divided the components of digital competency into six areas: Manipulation of digital devices; communication and collaboration; information retrieval, processing, management; problem solving and learning; security; and, digital ethics.

The factors derived as sub-components of digital competency in this study based on previous studies are as follows. It is composed of three areas: Technology, application, and mind. First, the sub-factors of the technology area are hardware, software, smart devices, and applications. Second, the sub-factors of the utilization area are information use, social life, and cultural life. Third,

the sub-factors of the mind domain are cognition, ethics, and law. A diagnostic tool for measuring and diagnosing the level of digital understanding and utilization should be developed centering on these digital competencies.

3. Research method

3.1. Research subject

In this study, a survey was conducted from March 14 to April 30, 2021, among college students enrolled in a four-year university in Gyeonggi-do, and the validation of the test tool was conducted based on the responses (Table 1). A total of 394 people responded to the questionnaire for measuring digital competence. For the recruitment of research subjects, an online survey was conducted after posting an advertisement for applicants on the website of the Faculty of Liberal Arts targeting those who took liberal arts courses. In addition, in order to comply with research ethical standards such as personal information protection and prior consent in online survey research conducted by individuals, consent forms from research participants were collected and submitted in electronic file form during the online survey.

Table 1: General characteristic (N=394)

Observational variable			Frequency	%
Gender		Male	108	27.4
		Female	286	72.6
Grade		1	104	26.4
		2	98	24.9
		3	103	26.1
		4	89	22.6
Department	College of Nursing	Department of Nursing (Seongnam)	61	15.5
		Department of Nursing (Daejeon)	1	0.3
	College of Health Sciences	Department of Clinical Pathology (Seongnam)	8	2.0
		Department of Clinical Pathology (Daejeon)	17	4.3
		Department of Optics	7	1.8
		Department of Medical Engineering	14	3.6
		Department of Emergency Rescue	16	4.1
		Department of Radiology	20	5.1
		Department of Dental Hygiene	8	2.0
		Department of Physical Therapy	13	3.3
		Department of Beauty and Cosmetic Science	14	3.6
		Department of Food and Nutrition	14	3.6
		Department of Food Industry and Food Service	10	2.5
		Department of Health, Environment, and Safety	10	2.5
		Department of Medical Management	24	6.1
	College of Bio Convergence	Medical IT Department	10	2.5
		Department of Medical Public Relations Design	15	3.8
		Department of Sports and Outdoors	67	17.0
		Funeral Guidance Department	12	3.0
		Department of Early Childhood Education	16	4.1
		Department of Children	23	5.8
		Department of Addiction Rehabilitation and Welfare	11	2.8
	Medical school	Department of Medicine	3	0.8

Looking at the gender composition of the respondents, there were 108 male students (27.4%) and 286 female students (72.6%), with male students more than three times higher than female students. The composition of the respondent grades was in the order of 1st grade (26.4%), 3rd grade (26.1%), 2nd grade (24.9%), and 4th grade (22.6%), but there was no significant difference according to the number of students between grades. As for the distribution by department, a total of 394 students from 23 departments participated, followed by the Sports and Outdoors Department (67 people), Nursing Department (Seongnam, 61 people), and Medical Management Department (24 people).

3.2. Research procedure

In this study, we intend to develop a digital competency measurement tool suitable for tools and platforms mainly used by Korean university students, and the digital native generation and analyze its feasibility. To this end, the factors composing digital competency were synthesized through a literature review on the constituent factors of digital competency. The sub-measurement items were developed focusing on the constituent factors of digital competency derived through literature review. The method of data collection through the developed measurement tool was to open an online survey web page and send an email to the participating students so that they could participate in the survey. Based on the collected data, we tried to derive the factors constituting digital competency by exploring the structural relationship of the components of digital competency and securing validity.

3.3. Research model

The main purpose of this study is to develop a digital competency measurement tool for Korean university students, the digital native generation, and to examine the feasibility of measurement indicators. In order to carry out the purpose of this

study, a research model is presented as shown in Fig. 1. This study conducted a quantitative study to develop a digital competency measurement tool for digital natives.

TECH: Technical area, AA) HARD: Hardware, AB) SOFT: Software, AC) SMART: Smart Device, AD) APPLE: Applications. USE: Application area, BA) INFO: Information Use, BB) SOCIAL: Social Life, BC) CULTURAL: Cultural Life. MIND: Mind area, CA) RECOGNITION: Recognition, CB) ETHICS: Ethics and Law.

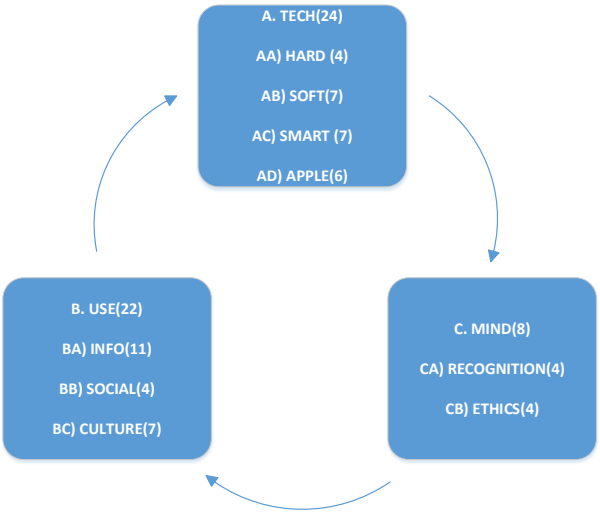

Fig. 1: Research model

3.4. Data analysis

The PASW Statistics 18.0 program was used to analyze the data collected to test this research question. First, a frequency analysis was conducted to examine the demographic and sociological factors of the subjects. In addition, to find out the digital competency level of university students, the digital native generation, the average value was calculated with descriptive statistics.

In addition, factor analysis was conducted to analyze the convergent validity among the constituent validity among detailed indicators within each area of the digital competency measurement tool. Factor analysis is a multivariate analysis technique that analyzes how several variables are connected to each other and explains the relationship between these variables using common factors (intrinsic dimension), and the correlation between variables. In some cases, the correlation is high. This is an analysis method whose main purpose is to implicitly reduce the number of variables by grouping variables with similar meanings among these variables to form new variables that are not related to each other. There are two types of factor analysis: Principle Component Analysis, which assumes that the intrinsic factor is zero, and Common Factor Analysis, which does not. In this study, the validity of the indicators was improved by first reviewing and adjusting the indicators through principal component analysis by domain, and sub-factors by domain were reclassified through common factor analysis.

4. Results

4.1. Digital competency level of university students

The sub-factors of college students' digital competency are composed of the technical area, application area, and mind area, and the level of each area is as follows (Table 2).

Table 2: Sub-factor analysis of the technical area

Sub-factor (number of questions)	M	SD
Hardware (4)	4.26	.698
Software (7)	3.97	.693
Smart device (7)	4.07	.782
Applications (6)	4.58	.611
All	4.22	.696

The overall average of the sub-factors in the technical area was 4.22, with applications showing the highest average of 4.58 and software with the lowest average of 3.97. It is understood that the ability to use applications is high because college students use smart devices a lot, and the ability to utilize computer programs that are used relatively less frequently appears to be low and tends to be difficult. Looking at the details, they answered that it was difficult to format and reinstall the computer or to edit photos, and make and edit videos using multimedia software (Table 3).

Table 3: Sub-factor analysis of application area

Sub-factor (number of questions)	M	SD
Information use (14)	4.58	.527
Social life (7)	4.56	.621
Cultural life (7)	4.76	.446
All	4.63	.531

The overall average of the sub-factors in the application area was 4.63, showing a high average value for all three sub-factors. The cultural life factor that recorded the highest average value consists of items in areas commonly used by college students, such as dramas, entertainment shows, watching movies, games, e-books, and listening to music (Table 4).

Table 4: Mind area sub-factor analysis

Sub-factor (number of questions)	M	SD
Recognition	4.48	.636
Ethics and law	4.40	.626
All	4.44	.631

The overall average value of the sub-factors of the mind area was 4.44, confirming the clear perception of cyberspace and information society. Ethics, laws, and regulations were found to be somewhat lacking compared to cognitive factors.

The lowest average value among all nine sub-factors was the software factor in the technical area (M=3.97), and it was the only one that showed an average value that did not reach 4.0. Among them, it was found that it was difficult to edit and produce

photos and videos by using more or less specialized programs such as computer installation questions, Photoshop, media player, and multimedia software. In order to create an online learning environment for learners of the digital native generation, it is necessary to develop educational content on how to use various multimedia software programs.

4.2. Validity of digital competency components

In this chapter, the validity of the digital competency components of the digital native generation derived through a literature review was analyzed. The analysis results are as follows.

4.2.1. Factor analysis results for digital competency components

KMO and Bartlett's test indicate how well the correlation coefficient between items is explained by other items. As a result of this data analysis, if the KMO value is .955, it can be said that the explanation is quite high. Bartlett's sphericity test indicates whether the factor analysis model is suitable, and it can be said that the significance probability value is .000 at the significance level of .05 (Table 5).

Table 5: KMO and Bartlett's test

Kaiser-Meyer-Olkin measures of sample adequacy		.955
Bartlett's sphericity test	Approximate chi-square	14209.163
	degrees of freedom	1431
	Significance Probability	0.000

Table 6 shows the results of factor analysis for the developed digital competency 54 measurement factors. The factor extraction method was principal component analysis, the rotation method was Varimax, and the factor extraction method was based on an Eigenvalue of 1.0. As a result of factor analysis, first, the commonality is the variance of variables explained by the extracted factors, and items with a commonality of .04 or less are judged to have low communality and are removed. However, none of the items in this study were less than .04, so the removed items did not appear among the 54 developed measurement factors. In addition, the structure of the factor calculated based on the Eigenvalue of 1.0 can be confirmed. In this study, the total explanatory variance of the 54-factor model was high at 66.25%. They were grouped into a total of nine factors. By factor, factor one is 40.33%, factor two is 6.43%, factor three is 4.77%, factor four is 3.21%, factor five is 2.92%, factor six is 2.47%, factor seven is 2.21%, factor eight is 2.01%, and factor nine is 1.87%. Factor loading is the degree of correlation between items (variables) and factors.

4.2.2. Digital competency components reviewed for construct validity

Factors were named based on item attributes to conceptualize the factors calculated based on the validity analysis results of the digital competency components of the digital native generation.

- Factor one consisted of a total of thirteen items. The result of exploring the items in factor one means the ability to use digital devices in information use and social and cultural life according to the use of digital devices. Therefore, factor one was defined as 'digital device utilization ability.'
- Factor two consisted of a total of ten items. The result of exploring the items composed of factor two means the ability to use digital smart devices and applications. Therefore, factor two was defined as the 'capability to use digital devices.'
- Factor three consisted of a total of six items. The result of exploring the items composed of factor three means the ability to use useful and practical software that improves the user's convenience. Therefore, factor three was defined as 'digital device utility usage ability.'
- Factor four consisted of a total of six items. The result of searching the items is composed of factor four, which means the ability to access and use information. Therefore, factor four was defined as 'information literacy ability.'
- Factor five consisted of a total of four items. The result of exploring the items composed of factor five means the ability to utilize technology in terms of digital device hardware. Therefore, factor five was defined as ‘the ability to use digital device technology.’
- Factor six consisted of a total of four items. The result of exploring the items composed of factor six means cognitive attitudes in the digital environment. Therefore, factor six was defined as 'digital environment cognitive ability.'
- Factor seven consisted of a total of four items. The result of exploring the items composed of factor seven means ethical attitudes in the digital environment. Therefore, factor seven was defined as 'digital environmental ethics ability.'
- Factor eight consisted of a total of four items. The result of exploring the items composed of factor eight means the ability to use digital devices in cultural life. Therefore, factor eight was defined as ‘the ability to utilize digital devices in cultural life.’
- Factor nine consisted of a total of four items. The result of searching the items composed of factor nine means digital device utility technology ability. Therefore, factor nine was defined as 'digital device utility technology capability.'

Modern society, represented by a digital society, is rapidly changing into an era in which the boundaries between physical, digital, and biological space are collapsing and converging along with technological development. Among the competencies required for future learners necessary for this digital society, digital competencies are included. Therefore, it should be possible to present the educational direction for the competency education of the digital

native generation by analyzing the sub-factors that make up digital competency.

Table 6: Factor analysis results for digital competency scale measurement factors

	ingredient									
	1	2	3	4	5	6	7	8	9	commonality
Usage information 9	.736	.208	.067	.079	-.016	.279	.100	.109	.174	.726
Usage information 10	.689	.270	.036	.132	.193	.188	.016	.228	.037	.692
Utilization society 4	.659	.120	.172	.343	.018	.242	.100	.073	.179	.701
Usage information 11	.657	.181	.174	.025	.235	.152	.116	-.030	.060	.591
Utilization culture 1	.622	.243	-.009	.196	.311	.103	.088	.277	.001	.676
Utilization society 1	.615	.162	.215	.183	.227	.064	.164	-.011	.251	.629
Usage information 8	.599	.179	.023	.110	-.025	.296	.031	.380	.238	.694
Usage information 7	.598	.236	.206	.319	-.035	.254	-.017	.165	.263	.726
Utilization culture 2	.573	.198	-.077	.240	.364	.051	.107	.362	-.093	.717
Utilization society 2	.568	.202	.146	.291	.329	.165	.148	.051	.066	.634
Utilization culture 4	.551	.179	.051	.162	.373	.018	.182	.300	-.034	.628
Utilization society 3	.551	.134	.277	.427	.050	.106	.220	.028	.093	.651
Utilization culture 5	.458	.262	.117	.286	.342	.132	.201	.254	-.037	.614
Technology smart 6	.160	.700	.093	.253	.170	.077	.114	.092	.164	.671
Technology app 2	.227	.671	.098	.149	.227	-.002	.012	.286	.059	.670
Technology application 1	.265	.667	.241	.095	.012	.199	.034	-.010	.082	.629
Technology smart 7	.178	.662	.295	-.049	-.066	.151	.049	.008	.081	.596
Technology smart 5	.143	.657	.352	.173	.129	.133	-.029	-.021	.022	.642
Technology app 3	.274	.563	.198	.227	.124	-.071	.176	.291	.088	.628
Technology smart 2	.098	.538	.333	.204	.138	.159	.155	-.004	.266	.591
Technology app 5	.468	.528	.056	.167	.186	.125	.033	.147	.170	.631
Technology app 6	.292	.525	.036	.395	.060	.115	.226	.104	.191	.633
Technology app 4	.361	.486	.035	.320	.306	-.034	.156	.349	.034	.721
Technology software 2	.049	.157	.729	.050	-.021	-.042	.141	-.077	.052	.592
Technology hard 4	.103	.111	.686	.078	.184	.205	.069	-.078	.064	.590
Technology software 1	.184	.215	.645	.009	.167	.021	.057	.177	.222	.690
Technology smart 4	-.007	.395	.635	.160	.004	.197	-.014	-.002	-.052	.627
Technology hard 3	.156	.060	.633	.064	.362	.074	.188	.136	.218	.670
Technology smart 1	.104	.230	.557	.264	.014	.072	.067	.178	.307	.580
Usage information 3	.233	.311	.132	.668	.109	.195	.117	.088	.208	.729
Usage information 5	.437	.221	.175	.655	.189	.047	.020	.057	.076	.746
Usage information 1	.343	.353	.143	.570	.303	.107	-.003	.136	.082	.716
Usage information 6	.392	.267	.207	.543	.159	.231	.075	.113	.176	.691
Usage information 2	.250	.330	.180	.476	.201	.159	.124	.084	.315	.618
Visual Hard 2	.266	.173	.260	.116	.693	.145	.184	.097	.095	.735
Technology hard 1	.238	.051	.257	.232	.635	.197	.067	.176	.093	.665
Technology software 4	.381	.300	.018	.111	.559	.145	.090	.052	.408	.759
Technology smart 3	.214	.494	.071	.183	.507	.160	.065	.133	.270	.706
Mind 2	.217	.178	.203	.131	.120	.782	.169	.051	.058	.797
Mind 1	.276	.108	.109	.038	.055	.707	.238	.181	.104	.704
Mind knowledge 4	.251	.098	.026	.236	.196	.646	.248	.225	.081	.704
Mind 3	.327	.185	.133	.218	.238	.614	.293	.161	.015	.752
Mind ethics 3	.056	.006	.118	.035	.019	.188	.823	.083	.004	.739
Mind ethics 2	.110	.082	.149	.067	.118	.128	.766	.242	.109	.732
Mind ethics 4	.192	.165	.058	.062	.222	.242	.682	.013	.082	.651
Usage information 4	.254	.082	.235	.262	-.018	.213	.417	-.146	.191	.472
Utilization culture 6	.219	.136	.063	.045	.059	.340	.122	.669	.116	.667
Utilization culture 3	.440	.115	-.014	.152	.250	.119	.132	.586	-.058	.671
Mind ethics 1	.183	.136	-.030	.409	.206	.331	.211	.436	.047	.609
Utilization culture 7	.384	.258	.211	-.004	.022	.331	.117	.405	.152	.569
Technology software 6	.147	.186	.292	.249	.254	.124	.025	.130	.635	.671
Technology software 5	.207	.229	.351	.127	.272	.171	.132	.023	.577	.642
Techsoft 7	.091	.220	.369	.133	-.197	-.030	.262	.081	.483	.596
Technology software 3	.383	.225	.159	.161	.380	.062	.103	-.174	.459	.706
Eigen price	21.78	3.47	2.57	1.73	1.57	1.33	1.19	1.08	1.01	
Explanatory variable	40.33	6.43	4.77	3.21	2.92	2.47	2.21	2.01	1.87	
Cumulative variance	40.33	46.76	51.54	54.76	57.68	60.15	62.36	64.37	66.25	
Number of questions	13	10	6	5	4	4	4	4	4	

Factor extraction method: Principal component analysis; Rotation method: Varimax; Basis of factor extraction: Eigenvalue (1.0)

Digital competency means the ability to judge the value of Internet information based on critical thinking ability, beyond the ability to use a computer and to reassemble and utilize information suitable for the purpose. These include the use of ICT devices and media, the ability to understand and utilize digital information, and the coding ability (Choi, 2018a; 2018b).

5. Conclusions and Implications

This study tried to develop a tool to measure the level of digital competency perceived by the digital native generation and examine its feasibility by analyzing the sub-factors constituting the digital competency defined in previous studies. Based on the developed digital competency concepts, test questions were prepared and applied to 394 four-year college students located in the metropolitan area to secure the validity of the test tool. As a result of measuring the digital competency of the students who participated in the test, the level of digital competency perceived by the students was found to be high overall, and in particular, the overall average of the application domain sub-factors showed a high average value for all three sub-factors. The cultural

life factor that recorded the highest average value consists of items in areas commonly used by college students, such as dramas, entertainment shows, watching movies, games, e-books, and listening to music. Also, the software factor in the technology area showed the lowest average value compared to other factors. Among them, the question regarding installation matters and the use of somewhat specialized programs showed a low level. Therefore, it suggests the need for professional education on how to use various multimedia software programs to strengthen the digital competency of the digital native generation.

As a result of analyzing the validity of digital competency components, the overall explanatory variance of the 54 component models developed in this study was found to be quite high. The digital competency components were grouped into nine factors and the final construct validity reviewed are 'digital device utilization ability,' 'digital device usage ability,' 'digital device utility usage ability,' 'information utilization ability,' 'digital device technology application ability,' 'digital environmental awareness ability,' 'digital environmental ethics ability,' 'digital device cultural life usage ability,' and 'digital device utility technology ability.'

Based on the above results, it was possible to confirm the validity of the measurement tool and further understand the characteristics of digital competency of the four-year E college students located in Gyeonggi-do. The measurement tool developed in this study can be used as basic data for selecting educational content and determining educational methods to enhance the digital competency of the digital native generation.

In the future, it should be possible to lay the foundation for creative convergence digital education, such as design thinking, computing, digital entrepreneurship, and start-up education, among the educational content to develop the capabilities of future society rather than digital education. The higher the level of digital competency, the more positive the impact is in the era of the Fourth Industrial Revolution. Digital competency also uses appropriate digital tools to evaluate, collect, process, and transmit information using digital thinking and future capabilities, creativity, collaboration ability, and cognition. Ability can be a stepping stone to the path of the 4th industrial revolution. In order to face a new era in which rapid changes are taking place, it is necessary to systematically organize regular subjects so that digital competency can be enhanced as a core competency that talents in the information society must have. Currently, the Ministry of Education in Korea is organizing software education as a regular subject and continues to promote leading education in elementary schools. However, the government and the Ministry of Education need continuous attention and monitoring so that they can become future core talents required by the 21st century.

Despite the positive implications of the results of this study, it has the following limitations.

First, there is a limit to generalizing the results of this study to all college students because the survey subjects were collected from a limited number of college students in one university.

Second, there are limitations in setting factors constituting digital competency and presenting a research model because there are not many previous studies and data on digital competency.

In addition to the limitations of this study, if research related to curriculum design in terms of educational content and method that can improve the digital competency of undergraduate students is conducted as a follow-up of this study, this study you may find other implications.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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