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The Factor Analysis of Information and Communication Technology Literacy for Primary School Students in South Korea*

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The purpose of this study was to identify the factors of ICT literacy in the primary school students in South Korea and to examine the gender and city size difference on the factor of ICT literacy. To accomplish this goal, we have analyzed the data of Korea Youth Competency Measurement and International Comparative Study I: ICCS 2016 which is nationally collected from the primary school students, currently on the 5 ~ 6th grades in South Korea. 1,188 samples were used in the study excluding missing samples. The participants were 584 5th grad and 604 6th grad students, 620 males (52.2%) and 568 females (47.8%). The mean age was 13.49 years (SD=.52). The result of the study reveals the four factors of ICT literacy through cross-validating exploratory factor analysis and confirmative factor analysis; *pleasure of using ICT, perceived usefulness of using ICT, learning ability with using ICT,* and *operating ability of ICT*. This study found that the leaner differ in gender on *learning ability with using ICT* and *pleasure of using ICT*. The female students were significantly larger than male students on *learning ability with using ICT*. However, the male students were significantly larger than male students on *pleasure of using ICT*. This study found that the leaner differ in city size on the factors of ICT literacy excluding *pleasure of using ICT*. The students living in the big size city were significantly larger than the students living in the middle and small. That is, over all, female students were more learning with ICT, male students were more interesting about ICT, and the students living in the big size city were more ICT use for learning. Based on the results, some strategies were suggested on the proper use of the factors of ICT in education.

Keywords : ICT literacy, Pleasure of using ICT, Perceived usefulness of using ICT, Learning ability with using ICT, Operating ability of ICT

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Introduction

Learning ability for 21th century

Over the past few years, the information and communication technologies (below ICT) have been rapidly changing society, culture, culture, and all of our life. In short, People in the 21st century live in a technology and media-suffused environment, marked by various characteristics, including access to an abundance of information, rapid changes in technology tools, and the ability to collaborate and make individual contributions on an unprecedented scale (Partnership for 21st Century Skills, 2015; Sung, 2015). To be effective in the 21st century, people should have the ability and skills related to adapting to the rapidly changing society and improving sustainable learning by using ICT.

The definition of information and communication technology literacy

The term ICT is being used increasingly by global industry, international media, and academics represents the set of activities and technologies to reflect the convergence between computer, information, internet network system, and communication technologies. The increasing role of technology in our lives requires us to expand our notion of ICT literacy. Looking at the definition of ICT literacy, Sung (2015) defined "ICT literacy is a creative problem-solving ability by exploring and sharing information individually/collaboratively with using information, media and technology in the context of situation as well as technical skills." Lee, et al (2007) defined "ICT literacy is the basic literacy skills to solve problem effectively using digital information technology and communication technology in information society. Suh, et al (2009) defined "ICT literacy is problem solving ability by applying required information to use information and communications technology (ICT) having information ethics". Educational Testing

Service (2007) defined "ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society." ISTE (2015) defined "ICT literacy is the ability of individuals to use ICT appropriately to access, manage and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society." Overall, the definition of ICT literacy include accessing, managing, evaluating, and creating information, communicating with others, problem-solving ability, using ICT effectively.

Which requires ICT literacy for 21th century learners?

To be improving learning ability in 21th century learners, which requires a factor of ICT literacy when learners are using ICT? Are there gender and city size differences on a factor of ICT literacy? If a factor of ICT literacy would be identified, the factor would be applied across all learning and real-life situations. For examples, factors of ICT literacy may be the basis for the development of measurement tools for measuring the level of ICT literacy. The measurement results of the level of ICT literacy may be used performance indicators as information education policy. Also, the results may be used reference data for developing ICT curriculum and improving teaching and learning method in ICT.

The purpose of this study

The purpose of this study is to identify the factor of ICT literacy for 21th century learners and to examine the gender and city size differences on the factor of ICT literacy. The four major research questions are as follows;

(1) What are the factors of ICT literacy?

(2) Does the factor structure of ICT literacy are the consistency?

(3) Is there any gender difference on the factors of ICT literacy?

(4) Is there any city size difference on the factors of ICT literacy?

Method

Data collection

The data of this study was used a data set of Korean Youth Competency Measurement and International Comparative Study I: ICCS 2016 that was nationally collected from primary school students who is currently on the 5 ~ 6th grades in South Korea. In this research, the sample group, a stratified clustered sample design was used, randomly selected 1,248 primary school students in 7 cities and 9 provinces in South Korea. Within the sample group, 1,188 samples were used in the study excluding missing samples. The participants were 584 5th grad and 604 6th grad students, 620 males (52.2%) and 568 females (47.8%). The mean age was 13.49 years (SD=.52).

Materials

The paper-based materials consisted of a participant questionnaire and the ICT literacy scale. A participant questionnaire solicited demographic information concerning the adolescence's age, gender, location, and year in school. We have developed the ICT literacy scale that was adapted the part of items from Choi, Kim, Kim (2009) consisted of 10 rating items such as information searching, learning with computer and internet, information editing, and so on. The students were asked to rate on a 4-point scale (with *strongly agree=4 to strongly disagree=1*) the level of frequency with which they used their computer for each item (e.g. "I can get a variety of information with using computer and internet.", "I can easily operate the various functions of computers and the Internet."). The reliability coefficient obtained by Chronbach's alpha was .867, and ranged from 0.843 to 0.865 for each subscale, indicating suitable reliability.

Data analysis

In order to identify and validate the factors underlying the ICT literacy for the primary school students in South Korea, we employed two kinds of analysis, exploratory factor analysis (EFA) and confirmative factor analysis (CFA). Also, based on the extracted factors, we have examined independent t-test and one-way ANOVA in order to identify gender and location differences. The analyses were conducted in five phases. The first phase involved identification of the standard normal distribution by verifying that the kurtosis (<7) and skewness (<2) were within an acceptable range (Chou & Bentler, 1995; Curran, West, & Finch, 1996). Reliability for each subscale were conducted based on the mean correlation between each pair of items in the subscale, to make sure they met the minimum Cronbach's alpha value (.700) considered adequate as a measurement tool (Brace, Kemp, & Snelgar, 2009). In the second phases, exploratory factor analysis (EFA) was employed. The data were screened by means of Kaiser-Meyer-Oklin(KMO) measure of sampling adequacy and Bartlettt's test of sphericity, and analyzed by means of a principal component analysis, with varimax rotation. In the third phase, confirmatory factor analysis (CFA) was conducted. CFA was used to cross-validate a priori defined factor structure of the ICT literacy by means of a repeated measure design. This cross-validation procedure was used to exclude the possible contingency of having high model fit in confirmatory analysis as a result of repeated adjustment by using the same sample in exploratory analysis (MacCallum, Roznowski, & Necowitz, 1992). As suggested by researchers (Bollen & Long, 1993; Breckler, 1990), multiple criteria should be adopted in order to assess the different aspects of goodness-of-it model fit indices. The overall fit of an unconstrained model was assessed by χ^2 goodness-of-it fit statistics (p>.05), comparative fit index (CFI, >90), turker-lewies index (TLI, >.90), the incremental index of fit (IFI, >.90), and root mean squared error of approximation (RMSEA, <.08) (Bentler, 1990; Browne & Cudeck, 1993; Byrne, 2001; Kline, 2005; Hu & Bentler, 1995; Steiger, 1990). In the final phases, we have examined independent t-test and one-way ANOVA in order to identify gender

and location differences(big city including metropolitan city, middle city including local area city, small city including rural area city), including effect size of Cohen's *d* (Cohen, 1988). To analyze the data, SPSS 18.0 and AMOS 18.0 were employed.

Result

Descriptive and reliability statistics of the ICT literacy measurement scaling

In order to identify the factor of the ICT literacy for the primary school students, the items of ICT literacy measurements were analyzed the mean, standard deviation, the standard normal distribution, and the reliability for each items. In Table 1, the total mean of the ICT literacy measurement scaling was 3.11(SD=.83), which ranged from 2.63 to 3.47 with standard deviations from .642 to .970. Skewness (<7) ranged from -1.034 to .005, and kurtosis (<2) ranged from -.956 to .981, thereby indicating that normality in distribution of collected data was verified. Based on reliability coefficients, Cronbach's alpha for the entire items was 0.867 that ranged from .843 to .865, indicating suitable reliability.

Table 1. Mean (and standard deviation) and reliability (N=1,188)

Items	Mean	Std. Deviation	Skewness	Kurtosis	Cronhach's α
q-01	3.47	.642	-1.034	.981	.853
q-02	3.32	.768	-.919	.207	.852
q-03	3.08	.915	-.583	-.708	.855
q-04	3.03	.970	-.607	-.730	.857
q-05	3.00	.872	-.418	-.728	.844
q-06	3.32	.739	-.844	.201	.843
q-07	3.04	.832	-.478	-.511	.851
q-08	2.63	.943	.005	-.956	.865
q-09	3.17	.786	-.678	-.066	.847
q-10	3.05	.849	-.544	-.441	.850
Total	3.11	.83			.867

Exploratory factor analysis of the ICT literacy

An exploratory factor analysis was conducted on the data (n=1,188) using the principal components method with varimax rotations in order to extract factors of ICT literacy for the primary school students. First, the KMO measure was found to be 0.808, which suggests that the sample is adequate for carrying out the factor analysis. In addition, Bartlett's test of sphericity was found to be significant, χ^2 = 3843.969, $p < 0.00$, which suggests that the strength of the relationship among the variables was strong, such that the data were suitable for conducting an exploratory factor analysis. In the final round of the EFA, the four factors were extracted from 8 items, which explained 82.468 % of the total variance. 2 items, cross-factor loading and low-factor loading items below 0.40, were eliminated from 10 items. The rotated factor loading matrix for each 8 items are presented in Table 2. For each item, the highest factor loading above .800 is indicated in bold.

We labeled the five factors as pleasure of using ICT, perceived usefulness of using ICT, learning ability with using ICT, and operating ability of ICT. Pleasure of using ICT loaded 2 of the 8 items and explained 47.028% of the variance with eigenvalue = 3.762 and factor loadings ranging from 0.841 to 0.889. Pleasure of using ICT included items such as "I am fun and happiness when I am using the computer and internet.", "I would like to use the computer and internet more." Perceived usefulness of using ICT loaded 2 of the 8 items, and explained an additional 18.173% of the variance, with eigenvalue = 1.454 and factor loadings ranging from 0.830 to 0.864. Perceived usefulness of using ICT included items such as "Using computer and Internet helps my work do better.", "Using computer and internet helps my work do more quickly" Learning ability with using ICT loaded 2 of the 8 items, and explained an additional 9.081% of the variance, with eigenvalue = .727 and factor loadings ranging from 0.838 to 0.852. Learning ability with using ICT included items such as "I can learn based on a variety learning materials such as movie clips (Youtube, TED, etc.), web documents with using computer and

internet.", "I can get a variety information with using computer and internet." Operating ability of ICT loaded 2 of the 8 items, and explained an additional 8.185% of the variance, with eigenvalue = .655 and factor loadings ranging from 0.808 to 0.847. Operating ability of ICT included items such as " I can creates and edit a document, image, movie clip with using word, power point, excel, photo shop programs.", "I can easily operate a variety functions of computer and internet."

Table 2. Factor loadings by exploratory factor analysis

Items	Component			
	1	2	3	4
q-08	**.889**	.230	-.001	.082
q-07	**.841**	.260	.182	.141
q-10	.252	**.864**	.177	.132
q-09	.284	**.830**	.176	.199
q-01	.114	.185	**.852**	.217
q-02	.056	.146	**.838**	.283
q-03	.053	.089	.287	**.847**
q-05	.182	.231	.214	**.807**
% of Variance	47.028	18.173	9.081	8.185
Cumulative %	47.028	65.201	74.283	82.468
Initial eigenvalues	3.762	1.454	.727	.655
KMO	.808			
Bartlett's test	3843.969			
Sig.	.000			

Confirmative factor analysis of the ICT literacy

In order to cross-validate a priori defined factors of ICT literacy, we conducted a CFA by means of a repeated measure design. First of all, multicollinearity was identified among the factors of ICT literacy as independent variables. If two or more factors in ICT literacy are highly correlated (>.08), the factors are referring to

redundant or same factors. Table 3 shows the correlation matrix among the factors of ICT literacy. As a results, there were significant positive correlations among all factors based on two-tailed tests with $p < .01$, ranged from $r = 0.254$ to $r = 0.568$, which indicate that are independent factors.

Table 3. Correlation matrix for the extracted four factors in ICT literacy

	1	2	3	4
1. Pleasure of using ICT	-			
2. Usefulness of using ICT	.561**	-		
3. Learning ability with using ICT	.254**	.423**	-	
4. Operating ability of ICT	.310**	.422**	.568**	-

The results of confirmative factor analysis were as follows. Table 4 shows result of standardized estimate of 8 items on four factors in ICT literacy, which ranged from β=.732 to 867 with $p<.01$

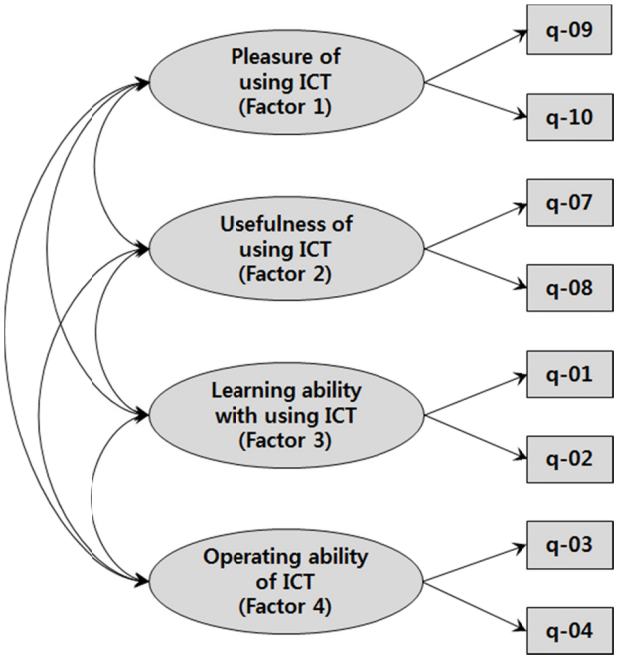
Table 4. Result of estimate from CFA model

	Items	Unstandardized estimate	Standardized estimate
Learning ability with using ICT	q-01	1.000	.788**
	q-02	1.197	.789**
Operating ability of ICT	q-03	1.000	.731**
	q-05	1.026	.787**
Pleasure of using ICT	q-07	1.000	.867**
	q-08	.993	.760**
Usefulness of using ICT	q-09	.974	.857**
	q-10	1.000	.814**

**: p<.01

In addition, as shown in Figure 1, the model fit of the factor model was not statistically significant based on a χ^2 goodness-of-it test, $\chi^2(df=14) = 80.636$,

p=.000. However, although the chi-square statistic is in essence a statistical significant test, it is highly sensitive with respect to model fit which means that the chi-square statistic tends to reject the model when the sample or model is larger (Bentler & Bonnet, 1980; Kline, 2005; Jöreskog & Sörbom, 2004). Due to chi-square limitations, we adopted other multiple indices to assess model fit such as CFI, TLI, IFI, and RMSEA. As a result of a comparison of these indices, the factor model was supported by most of all the fit indices; CFI=.983 (>.900), TLI=.955 (>.900), IFI=.983 (>900), and RMSEA=.063 (<.080), which were within acceptable ranges. The result indicated that the four factors of ICT obtained from EFA were validated.



χ^2(CMIN): 80.636(df=14, p<.05), CFI: 0.983, TLI: 0.955, IFI: .983, RMSEA: 0.63

Figure1. CFA models in the factors of ICT literacy

Gender and city size differences on the factors of ICT literacy

Based on the results, we have examined whether the primary school students differed in gender on the factors of ICT literacy. Table 5 shows not only the mean ratings and standard deviations, but also the results of the t-test on gender differences including Cohen's effect size. As shown in Table 5, there were not significant differences in gender of the total score of ICT literacy at the level of p>.05. In the sub scale score of the ICT literacy, however, there were significant differences in gender of *learning ability with using ICT* (t=-5.911, p<.01, d=.35) and *pleasure of using ICT* (t=6.151, p<.01, d=.36) at the level of p<.05.

Female students were higher than male students in *learning ability with using ICT*. On the contrary, male students were higher than female students in *pleasure of using ICT*.

Table 5. Mean (and standard deviation) and T-value for gender on the factor of ICT literacy by independent-samples T-test

	Gender	N	Mean	SD	t	d
Total	Male	621	3.11	.57	.640	-
	Female	567	3.09	.56		
Learning ability with using ICT	Male	621	3.29	.67	-5.991**	.35
	Female	567	3.51	.58		
Operating ability of ICT	Male	618	3.01	.80	-1.401	-
	Female	567	3.08	.79		
Perceived usefulness of using ICT	Male	617	3.15	.73	1.773	-
	Female	566	3.08	.78		
Pleasure of using ICT	Male	620	2.97	.76	6.152**	.36
	Female	567	2.69	.83		

In the second place, there was analyzed city size difference on ICT literacy. Table 6 shows not only the mean ratings and standard deviations, but also the results of the t-test on city size differences including Cohen's effect size. As shown in Table 6,

total mean score of ICT literacy in the primary school student in South Korea was 3.10 (SD=.56). *Learning ability with using ICT* was highest score (M=3.40, SD=.63) and *pleasure of using ICT* was lowest score (M=2.83, SD=.80). On the whole, mean score of students who lived in big city (M=3.16, SD= .56) was higher than students

Table 6. Mean (and standard deviation) and F-value for city size on the factor of ICT literacy by ANOVA

		N	Mean	Std. Deviation	F	Post Hoc Tests
Total	Big city	476	3.16	.56	5.855**	Big>Middle =Small
	Middle city	611	3.04	.57		
	Small city	101	3.08	.49		
	Total	1,188	3.10	.56		
Learning ability with using ICT	Big city	476	3.50	.59	11.609**	Big>Middle =Small
	Middle city	611	3.32	.65		
	Small city	101	3.33	.62		
	Total	1,188	3.40	.63		
Operating ability of ICT	Big city	475	3.11	.77	2.990*	Big>Middle =Small
	Middle city	609	2.99	.80		
	Small city	101	3.01	.75		
	Total	1,185	3.04	.79		
Perceived usefulness of using ICT	Big city	473	3.19	.75	4.935**	Big>Middle =Small
	Middle city	610	3.04	.76		
	Small city	100	3.10	.61		
	Total	1,183	3.11	.75		
Pleasure of using ICT	Big city	475	2.84	.80	.343	
	Middle city	611	2.81	.80		
	Small city	101	2.88	.83		
	Total	1187	2.83	.80		

who lived in middle (M=3.04, SD=.57) and small size city (M=3.08, SD=.49) at level of $p<.05$, F=5.855. In the factors of ICT literacy, there were significant

differences in city size on *learning ability with using ICT* (F=11.609, p<.05), *operating ability of ICT* (F=2.990, p<.05), *perceived usefulness of using ICT* (F=4.935, p<.05) excluding *pleasure of using ICT*. Students who were living in big size city were higher score of the ICT literacy than students who were living in middle and small size city.

Conclusion

The present study was to identify the factors of ICT literacy and to investigate how gender and city size difference on the factors of ICT literacy in the primary school students in South Korea.

The result of the study reveals the four factors of ICT literacy through cross-validating exploratory factor analysis and confirmative factor analysis; *pleasure of using ICT, perceived usefulness of using ICT, learning ability with using ICT,* and *operating ability of ICT*. The major factor of ICT literacy was *pleasure of using ICT* because of positive attitude and belief of learners based on the interest about computer and internet media. *Perceived usefulness of using ICT* is considered as a factor based on positive experience when learner uses the technology to perform learning and task effectively. *Learning ability with using ICT* is considered as a factor based on perceived learning efficacy when leaner learn better by obtaining learning materials and information with using ICT. Finally, *operating ability of ICT* is referring to technical skill to use computer and internet effectively and efficiently. Also, this study found that the leaner differ in gender on *learning ability with using ICT* and *pleasure of using ICT*. The female students were significantly larger than male students on *learning ability with using ICT*. However, the male students were significantly larger than male students on *pleasure of using ICT*. This study found that the leaner differ in city size on the factors of ICT literacy excluding *pleasure of using ICT*. The students living in the big size city were significantly larger than the students living in the middle and small. That is, over all, female students were more learning with ICT, male students

were more interesting about ICT, and the students living in the big size city were more ICT use for learning.

ICT literacy cannot be defined primarily as the mastery of technical skills. This study has contributed what the concept of ICT literacy was extended to include both the application of technical skills and knowledge as *perceived usefulness of using ICT, learning ability with using ICT* and technical skills as *operating ability of ICT* as well as affective domain as attitude and belief as *pleasure of using ICT*.

Based on those result, we have suggested further research topics as follows; 1) the factors of ICT literacy may be the basis for the development of measurement tools for measuring the level of ICT literacy. 2) The measurement results of the level of ICT literacy may be used performance indicators as information education policy. 3) The results may be used reference data for developing ICT curriculum and improving teaching and learning method in ICT. 4) Students who are living in the middle and small city should be provided education program for improving ICT literacy to decrease digital divided in Korea.

This study is subject to limitations of deciding research questions, and selecting methodology due to this study's utilizing the data from 'Korea Youth Competency Measurement and International Comparative Study I: ICCS 2016'. Therefore, for further research, it would be necessary to investigate the difference among the level of ICT literacy on learning attitude, situational skill ability, and academic achievement.

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