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Adaptation of higher education students' digital skills survey to Russian universities

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Abstract
Digital skills are essential for a technologized society. For younger generations, it has become almost necessary to have such skills. This study focuses on a valid and reliable measurement tool to determine the digital skills of university students. The research was carried out with the participation of a total of 463 university students. Exploratory factor analysis and confirmatory factor analysis were conducted to investigate the validity and reliability of the digital skills survey. Consequently, research on the validity and reliability of the digital skills survey in the Russian environment was conducted. 25 items and six factors (access to and management of digital content, digital empathy, use of digital means, digital safety, communication of digital content, creation of digital content) were identified after the analysis. Future research should employ the adapted survey to assess the level of students' digital skills. In addition, the survey's validity may be analyzed in the context of other cultures.

Keywords: digital skills, undergraduate students, psychometric properties

INTRODUCTION

The development of new technologies, increasing internationalization, and lightning-fast information acquisition are the defining features of modern civilization (Martin et al., 2022; Raja & Nagasubramani, 2018; van de Oudeweetering & Voogt, 2018). People can now actively contribute to expanding knowledge through the Internet rather than just receiving information (Gretter & Yadav, 2016). Non-routine and interactive activities are gaining prominence in the workplace, while routine and laborious tasks can be increasingly automated or performed by robots (Neubert et al., 2015; Sacks et al., 2020). Many researchers and policymakers believe that teachers have a central role in helping students acquire the 21st century skills necessary for success in the workplace (Gretter & Yadav, 2016; Kim et al., 2019; van Laar et al., 2019).

Digital citizenship is the ability to identify successfully, access, utilize, and product information; interact actively, critically, empathically, and ethically with people and materials while navigating digital environments; and behave safely and responsibly (UNESCO Office Bangkok and Regional Bureau for Education in Asia and the Pacific, 2016). In attempting to plan education and training initiatives to improve critical skills needed for personal development, social inclusion, active citizenship, and employment, many policymakers have taken an interest in the concerns of learning in the digital age. The report titled "A new skills agenda for Europe" highlighted the problems European companies face when hiring well-trained individuals with an appropriate balance of digital skills,

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Contribution to the literature

- Digital skills are both a crucial component and supporter of digital literacy, which is expressed in 21st-century skills. Every country needs valid and reliable instruments to determine whether these digital skills of young people with their own future are developed or not. In this sense, the study offers a valid and reliable instrument that can be used to measure the digital skills of university students.
- The study provides a roadmap for the processes to be followed for scale adaptation.
- It will contribute to the literature as it has also examined the criteria that can be used to measure digital skills.

entrepreneurship, and innovative thinking (Fleaca & Stanciu, 2019).

Although information and communication technologies (ICTs) are ubiquitous in the workplace, not all workers have the necessary skills to benefit from the variety of activities and range of learning opportunities that ICTs offer. The digital literacy level varies significantly across individuals, as several studies have shown (Spante et al., 2018, van Deursen & van Dijk, 2015; Verhoeven et al., 2016; Wahjusaputri & Nastiti, 2022)

Digital competencies are viewed as the ability to understand and articulate the transformation of information into knowledge, operations, and services using ICT and social software in analytical, productive, and innovative ways (Ala-Mutka, 2011; Burgos-Videla et al., 2021; Ferrari et al., 2012; Torres-Coronas & Vidal-Blasco, 2011). According to Voogt et al. (2013), digital literacy is the safe and critical use of digital technology at work and leisure.

"Digital competence" has become a central term in the discussion about the skills and knowledge people need to have in the knowledge society. Digital competence encompasses information management, collaboration, communication, knowledge generation, ethics and responsibility, evaluation and problem solving, and technological operations (Erwin & Mohammed, 2022; Ferrari, 2013; Voogt et al., 2013). Similar characteristics are highlighted in descriptions of "21st century talent." 21st century learning promises that digital tools will transform traditional education and mobilize the skills needed in the emerging digital world. Undergraduates are sometimes referred to as "digital natives" because they live in a digital world and use digital technologies in various everyday activities; therefore, they are expected to acquire several essential digital skills (Soroya et al., 2021; van Laar et al., 2017).

Digital skills have attracted great interest worldwide because those with the appropriate digital skills can benefit from modern digital technology (van Laar et al., 2017). For students, digital skills facilitate access to educational content, information management, and efficient use of e-learning as an educational medium (Fan & Wang, 2022; Soroya et al., 2021; Tameryan et al., 2022; Youssef et al., 2022). According to Gilster (1997), digital skills were mainly related to computer use. Over time and with the development of new digital technologies, digital skills has evolved into a term that encompasses a broader range of skills and is associated with several different abilities (Fan & Wang, 2022; van Laar et al., 2017).

The study of digital skills was conducted in different sectors and at varying levels of education. van Laar et al. (2019) surveyed working professionals. The results highlight an additional barrier to skill development, as recommended skills vary by individual background characteristics. Developing each skill requires not only a specific learning sequence and consideration of many factors. Self-directed learning, for example, contributes to the amount of digital information and problem-solving skills but has little effect on digital communication, teamwork, creativity, or critical thinking. Youssef et al. (2022) studied the relationships between ICT use, digital skills, and academic achievement among French students. The result is that acquiring digital skills improves students' academic performance.

The study of Estonian and Latvian students' digital skills shows that they are quite competent. However, storing information in the cloud, editing videos/photos, solving technological problems related to mathematics studies, and solving security issues were the most challenging for students (Aruvee & Vintere, 2022). According to studies conducted on university students in Greece, there is a clear positive correlation between YouTube use and digital skills in content evaluation and protection. The key finding is that students' digital skills are not affected by their widespread use of Facebook and Instagram. However, research suggests that social media, when used for instructional purposes, social media can influence students' perceptions of digital skills (Perifanou et al., 2021).

The methods used to evaluate digital skills are as varied as the conceptual meanings assigned to them. Three ways are mentioned in measuring Internet skills, which are recognized as digital skills. First, surveys that include questions about Internet use or program use are expected to provide indirect evidence of skill mastery. Second, surveys contain questions that ask for self-evaluations of skills. This is the most commonly used method. Third, performance evaluations in a laboratory or other controlled environment provide people with specific tasks to assess their Internet proficiency (van Deursen et al., 2014).

Self-assessment surveys are easier to use and are preferred by many researchers (Ghomi & Redecker, 2019; Martzoukou et al., 2021; Mirķe et al., 2019). This study investigates the validity and reliability of a survey that can be used to measure the level of digital skills of Russian and Kazakh students.

METHOD

Initially, attention was given to the linguistic validity of the scale, and then the focus shifted to the study of validity and reliability. This was done to determine the adaptation and psychometric properties of the scale in the context of the Russian language.

The data for the study came from participants enrolled in higher education programs in Russia and Kazakhstan. A total of 463 students participated in the study. With this sample size, it is possible to conduct exploratory and confirmatory factor analysis (CFA). Participants were 17 years old (1.3%), 18-19 years old (44.7%), 20-21 years old (25.3%), and 22 years old and older (28.7%). While 72.1% of participants are female, 27.9% are male.

Data Collection Tool and Process

The survey items were taken from a study by (Fan & Wang, 2022). Analyses were conducted on the validity and reliability of the survey. There are six factors in the survey.

The first factor was named "digital empathy". It measures a person's cognitive and emotional ability to be introspective and socially empathic while skillfully using digital materials. This aspect reflects an earlier theoretical notion of a facet of digital skills that we have termed digital empathy skills. The second factor is "access to and management of digital content." It evaluates an individual's capacity to identify, successfully access, use, and manage digital content. The third factor is the "use of digital means." It measures the ability to use various digital methods to achieve specific goals. The ability to protect one's privacy and digital material while operating in digital environments was the fourth and final factor, named "digital safety." The fifth factor is "communication of digital content." It evaluates the requirements and opportunities to share digital content with others. The sixth factor is named "digital content creation." It evaluates a person's ability to create and modify new digital content.

The research was conducted in two parts. The first phase emphasized language validity. First, the technology-savvy translation team translated the original scale from English into Russian. Later, the other translation team translated the scale items from Russian back into English. The authors then contrasted the two translations. Since they are semantically equivalent, linguistic validity was considered sufficient. Next, 20 students from the target category of university students were instructed to read the survey items. The target audience rated the readability and comprehension of the survey questions. In the second step, a sample was drawn to collect data for calculating the scale's psychometric properties.

Data Analysis

The instruments were evaluated to determine their validity and reliability. First, it was determined if the data followed a normal distribution. The skewness and kurtosis values are compared to the critical values to verify normality. Skewness ranges from -0.601 to -1.094, and kurtosis ranges from -0.536 to 0.312, both of which indicate that the measurements are normally distributed (Kim, 2013). The second step was the exploratory factor analysis (EFA). Williams et al. (2010) give five stages for factor analysis. Data suitability check, factor extraction, criteria determination, rotation technique selection, and interpretation. In the first stage, the sample size is evaluated. The sample size exceeds 300 and is sufficient. Then we examined the Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests. In the second phase, the factoring of the principal axes was used as the extraction approach. Parallel analysis is used to calculate the number of components. Moreover, the loading factor was above 0.40. In the fourth phase, 'Promax's rotation mechanism was used.

The structure was then examined by CFA. Descriptive statistical analyses and an examination of internal consistency (Cronbach's alpha) were also conducted to determine the instrument's reliability. X^2/df, the comparative fit index (CFI), the incremental fit index (IFI), the root mean square error of approximation (RMSEA) and its 95% confidence interval (CI), and the standardized root means square residual was used to accept or reject the tested model (SRMR). Values of 2/df less than three, IFI values at or above 0.95, and RMSEA and SRMR less than or very close to 0.06 and 0.08, respectively, were considered indicative of good data fit of the model (Kline, 2005). JASP (2021) is used for all analyzes.

FINDINGS

First, EFA is performed, followed by CFA to validate the results. In the last part, the results are discussed in terms of reliability.

Factor Analysis

The KMO measure of sampling adequacy and Bartlett's test of sphericity were validated to assess whether factor analysis was appropriate for the sample. The sample was suitable for EFA because the KMO value was 0.978 (>0.6), and the measure of Bartlett's test

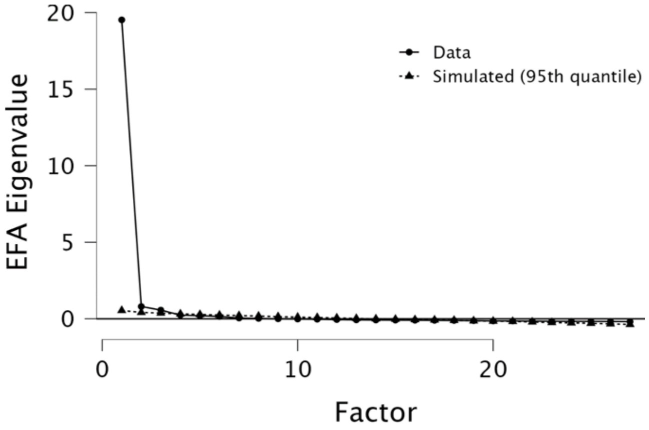

Figure 1. Scree plot

(X^2=16,942, df=35.1 p<0.001) was less than 0.001, indicating that the sample was suitable for EFA.

To examine the latent factor structure of the survey, EFA was performed using principal axis factorization and a Promax rotation approach. The number of factors is defined by the proportion of variation explained by the factors and the number of factors with an eigenvalue greater than one (**Figure 1**).

The factor loadings determine the components that make up a factor. Loadings greater than 0.4 factors are essential for an item to be included in a factor. The following criteria are used to determine items omitted from a factor: items with factor loadings less than 0.4 were eliminated. **Table 1** depicts factor loading for each factor.

While the lowest factor loading was 0.489 within the six-factor structure, the highest was 0.933. In analyzing the items collected for factor 1, the factor continued to be referred to by its name because these items were associated with the "access to and management of digital content" factor included in the original scale. Since the components collected under factor 2 were related to digital empathy, we gave them the name "digital empathy." Since "use of digital means" is the name given to both the items collected under the third factor and the items measuring digital media use skills, we gave the items collected under the fourth factor the name "digital safety" because they are related to the process of providing security in digital environments. Because the factor loading of the item "when sharing digital information with others, I am able to protect my privacy

Table 1. Factor loading for each factor

Items	F1	F2	F3	F4	F5	F6	U
DG2-I am able to search for and access information in digital environments.	0.933						0.108
DG4-I am able to search for information that I need on the Internet.	0.859						0.103
DG3-I can use different tools to store and manage information.	0.755						0.139
DG5-I can understand the information I get from the Internet.	0.678						0.114
DG1-I have apps that keep me up to date with news.	0.678						0.318
DG7-I skillfully use digital software to complete learning tasks.	0.522						0.132
DG30-I am willing to help other people in digital environments.		0.820					0.141
DG33-I consider the opinion of others in digital environments.		0.792					0.125
DG32-I respect other people in digital environments.		0.763					0.086
DG_29-I am able to put myself in other people's shoes in digital environments.		0.651					0.226
DG34-I get informed before commenting on a topic.		0.599					0.193
DG12-I can use digital means to solve problems encountered in my study.			0.902				0.100
DG9-I can create and edit digital content with higher standards according to the requirements of work or study.			0.680				0.224
DG13-I am able to use digital means to detect plagiarism in content that I created.			0.673				0.209
DG8-I can complete digital content that meets the minimum requirements of learning tasks.			0.622				0.126
DG28-Before doing a digital activity (e.g., uploading a photo or comment), I think about the possible consequences.				0.796			0.190
DG27-I avoid behaviors that are harmful on social networks.				0.667			0.136
DG26-I am able to identify harmful behaviors that can affect me on social networks.				0.630			0.179
DG25- I avoid having arguments with others in digital environments.				0.609			0.328
DG23-I am careful with my personal information.				0.437			0.230
DG15-I know how to communicate with others through different digital means.					0.725		0.077
DG16-I know how to communicate with others in different ways (e.g., images, texts, videos, etc.).					0.625		0.123
DG14-I can communicate with others in digital environments.					0.583		0.098
DG20-I am able to accurately present what I want to deliver in digital environments.						0.536	0.196
DG21-I can transform information and organize it in different formats.						0.489	0.161
DG19-I know different ways to create and edit digital content (e.g., videos, photographs, texts, animations, etc.).							0.158
DG37-When sharing digital information, I am able to protect my privacy & security.							0.299

Note. "Principal axis factoring" extraction method was used in combination with a "promox" rotation; U: Uniqueness; & F: Factor

Table 2. The variances and total variances of the factors

Factor	# items	SS loadings	Proportion variance	Cumulative variance
Access to and management of digital content	6	5.318	0.197	0.197
Digital empathy	5	4.611	0.171	0.368
Use of digital means	4	3.960	0.147	0.514
Digital safety	5	3.562	0.132	0.646
Communication of digital content	3	2.528	0.094	0.740
Creation of digital content	2	1.930	0.071	0.811

Table 3. Fit indices for the initial model and last model

	χ^2/df	CFI	TLI	NFI	SRMR	RMSEA	RMSEA 90% CI	
							Low	High
Cut-off criteria	≤3	>0.90	>0.90	>0.90	<0.08	<0.08		
Initial model	1081/260=4.16	0.947	0.939	0.932	0.028	0.083	0.078	0.088
Last model	737/247=2.98	0.969	0.962	0.954	0.025	0.065	0.060	0.071

Note: df: Degree of freedom; CFI: Comparative fit index; TLI: Tucker-Lewis index; NFI: Normed fit index; SRMR: Standardized root mean square residual; & RMSEA: Root mean squared error of approximation

and security" was included in the original scale but was later deleted because it had a value of less than 0.4, the item was not included in the scale. Because the focus is on communication abilities, the components that fall under the fifth aspect are referred to as "communication of digital content."

The information gathered under the 6th item was given the name "creation of digital content" because the information gathered under this factor is relevant to the creation of digital material. Since the factor loading of the item "I know different ways to create and edit digital content (e.g., videos, photographs, texts, animations, etc.)" under this factor was less than 0.4 in the original scale, the item was removed from the scale.

"Access to and management of digital content" alone can only explain 19.7%. In other words, the scale is not a single-factor structure. 25 items and six factors can explain 81% of the scale. **Table 2** shows the variances and total variances of the factors.

Confirmatory Factor Analysis

A study of the CFA test model revealed that the latent variable is real, suggesting that it is possible to continue processing it to verify the structural model.

CFI, TLI, NFI, and SRMR fit indices in the initial model are acceptable but not perfect, but χ^2/df is greater than three, and RMSEA is bigger than 0.08. So, the initial model is not acceptable (**Table 3**).

To obtain a more appropriate model, we added the covariance links recommended by the software, which led to the creation of the new model. When examining the final model fit indices, we find that CFI, TLI, and NFI are more than 0.95, which is at a perfect level, while the values for SRMR and RMSEA are less than 0.08 (Hair et al., 2014). According to the CFA, the digital skills survey is satisfactory.

At a statistical significance level of p=0.001, the relationship between each item and the relevant variables can be considered statistically significant for all items. The results of the CFA show that there is not a single item that should be removed (**Table 4**).

Reliability Analysis

The critical value for reliability is 0.7. If the reliability values are between 0.70-0.79, it is at an acceptable level. When they are greater than 0.9 (Hair et al., 2014; Oosterwijk et al., 2016), **Table 5** shows that the Cronbach's alpha, McDonald's, and Guttman's λ^2 values for each factor are greater than 0.9. It was also found that the total scale of each reliability value is 0.985, which is at an excellent level.

DISCUSSION AND CONCLUSION

The study aims to measure the validity and reliability of a scale measuring the level of digital skills of Russian college students. The survey was conducted in Kazakhstan and Russia in the spring of 2022. The digital skills survey was validated using EFA and CFA on 463 students.

The EFA methodology is a multivariate statistical tool (Edwards & Bagozzi, 2000; Watkins, 2018). KMO (0.978) and Barlett's test (X^2=16,942, df=35.1 p<0.001) were calculated in the EFA to determine the fit of the data. Both values are quite high (Yong & Pearce, 2013). Principal axis factorization and the Promax rotation approach were applied to obtain stronger factors. Eigenvalues and scree plots are evaluated to determine the factor number. Within the 6-factor structure, the lowest factor loading was 0.489, and the highest was 0.933.

Because the items were not distributed as the factor structure in the study (Fan & Wang, 2022), the factor names were reconstructed by examining the items. When the items collected for factor 1 were assessed, the factor was still referred to by its previous name because these items were associated with the "access to and management of digital content" factor of the original scale. Since the components collected under factor 2 are related to digital empathy, we named them "digital

Table 4. Factor loading, z-, and p-values

Factor	Indicator	Estimate	Standard error	z-value	p-value
Access to and management of digital content	DG1	0.610	0.042	14.378	<.001
	DG2	0.251	0.019	12.996	<.001
	DG3	0.203	0.017	12.144	<.001
	DG4	0.253	0.019	13.143	<.001
	DG5	0.193	0.016	12.225	<.001
	DG7	0.203	0.017	12.306	<.001
Digital empathy	DG29	0.437	0.032	13.678	<.001
	DG30	0.358	0.027	13.308	<.001
	DG32	0.152	0.015	10.167	<.001
	DG33	0.201	0.018	11.173	<.001
	DG34	0.238	0.019	12.196	<.001
Use of digital means	DG8	0.222	0.020	11.356	<.001
	DG9	0.354	0.027	13.003	<.001
	DG12	0.227	0.020	11.342	<.001
	DG13	0.359	0.029	12.433	<.001
Digital safety	DG23	0.328	0.026	12.765	<.001
	DG25	0.475	0.034	14.021	<.001
	DG26	0.229	0.018	12.690	<.001
	DG27	0.245	0.021	11.951	<.001
	DG28	0.330	0.025	13.338	<.001
Communication of digital content	DG14	0.151	0.013	11.228	<.001
	DG15	0.111	0.012	9.622	<.001
	DG16	0.198	0.016	12.254	<.001
Creation of digital content	DG20	0.288	0.026	10.967	<.001
	DG21	0.212	0.025	8.573	<.001

Table 5. Reliability results for factors and total scale

Factors	# items	McDonald's ω	Cronbach's α	Guttman's λ^2
Access to and management of digital content	6	0.959	0.959	0.960
Digital empathy	5	0.952	0.953	0.953
Use of digital means	4	0.941	0.941	0.941
Digital safety	5	0.939	0.939	0.939
Communication of digital content	3	0.957	0.957	0.957
Creation of digital content	2	-	0.907	0.907
Total	25	0.985	0.985	0.985

empathy." Because "use of digital means" is the name for both the items in the third factor and the items in the fourth factor that assess the ability to use digital media, the items in the fourth factor were called "digital safety" because they have to do with the process of ensuring security in digital environments.

Since the factor loadings of the item "when sharing digital information with others, I am able to protect my privacy and security" were less than 0.4, the item was removed from the scale. Because the focus is on communication skills, the components of the fifth aspect are referred to as "communication of digital content." The information collected under the sixth component is referred to as "creation of digital content" as it relates to the process of producing digital content. Since the factor loadings of the original scale item "I know different ways to create and edit digital content (e.g., videos, photos, texts, animations, etc.)" were less than 0.4, the item was deleted from the scale.

A CFA test model analysis was performed to determine if the structure in the digital skills survey is correct and if the structural model can be further validated. The values of CFI, NFI, and TLI are above 0.95; the values of SRMR and RMSEA are less than 0.08 (Hair et al., 2014). The survey is consistent with the conclusions of the CFA. In addition, the overall scale reliability for each value was found to be 0.98, which is an excellent level.

Consequently, research was conducted on the validity and reliability of the digital skills survey in the Russian environment. After the analysis, 25 items and six factors were identified. It is suggested that future researchers investigate the validity and reliability of the digital skills survey with multiple groups. In addition, the use of the survey to measure the level of students' digital skills is recommended for future studies. The survey's validity may be analyzed in the context of other cultures. Due to the use of the online survey system in the study data collection, the participants may not be representative of all students in the university.

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Ethical statement: The authors stated that the studies with human participants were reviewed and approved by Peoples' Friendship University of Russia on April, 2022 with approval code: RUDN386. No animal studies are presented in this manuscript. No potentially identifiable human images or data are shown in this study.

Declaration of interest: No conflict of interest is declared by authors.

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