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Pre-service TVET Teachers' Digital Competence: Evidence from Survey Data

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***Abstract* – This study sought to translate and validate the Digital Competence Scale for University Students among Kazakhstani undergraduate students aimed at the Technical and Vocational Education and Training (TVET) educator diploma (n = 202), and also to discover the status quo of their digital competence. The translation and trans-cultural validation of the scale produced a bi-factorial 10-item instrument, like the original. The questionnaire evidenced acceptable validity and reliability. On average, the participants reported a medium digital competence score. Practical implications and directions for future research are provided.**

***Keywords* – DC-US, survey, technology, undergraduate students.**

1. Introduction

Although it is widely believed that teenagers are digitally literate nowadays, research evidence reveals that the notion of digital natives fluent in technology since they grew up in a digital world is fallacious, and young students frequently lack digital competence [1].

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Digital competence may be defined as an individual's capacity to utilize the tenets of information and technology within a certain context [2].The notion of digital competence stems from a brand new vision of learning that benefits from technologies as a way of learning rather than just a medium [3]. While it is true that digital competence is one of the components necessary for any professional's lifelong learning regardless of the disciplinary area, it has become an indispensable part of teacher training and activity these days. To reflect the recent proliferation of smart devices and social media in people's daily lives, educational reforms worldwide have urged the incremental integration of technology into learning and training [4],[5]. In light of the above, pedagogues are encouraged to study how to use digital technologies correctly and deliver meaningful, scientifically and technologically updated instruction, which is in line with the Technological Pedagogical Content Knowledge framework [6]. Vocational-type institutions thus need educators equipped with not only workplace-related competencies but also digital competence required for facilitating learning by designing new learning environments [1]. This is believed to serve as a motivating element in learning [7] and help students face the demands of the upcoming labor context [3].

Sufficient practical technology skills as well as the ability to work effectively with theoretical applications are vital for incorporating educational technology into the 21st-century classroom [8]. As shown by research [9], all types of digital abilities, such as dealing with Internet technology security or information literacy, are becoming crucial in technical and vocational education and training (TVET). Nevertheless, the academic field has paid meager attention to the digital competence of those who specialize in TVET. In the meantime, TVET is a means for social change and improvement that can be looked at as a real and increasingly important training and employment option for the future.

Although much effort was devoted to measuring one's digital competence within academic settings through assessment scales, particularly for the purpose of identifying the areas that should be developed, practically all of the instruments suffer from some flaws. For example, [10] modified and translated German D21-Digital-Index into English, and its construct validity was confirmed by several analyses undertaken by the authors. In our view, the items comprising the questionnaire are too brief (e.g., 'Programming' or 'Installation of devices') which can leave room for misinterpretation of the item meaning by the respondent and thus hamper the implementation of the inventory. There are few scales addressing TVET. For instance, a self-assessment tool anchored on the European Framework for Digital Competence of Educators [11] has been recently adjusted to the TVET domain [12]. The fact is that this measure was designed for in-service teachers and therefore particularly observes whether the surveyee is capable to use digital technologies in order to collaborate with colleagues from the educational institution, which may be not applicable for students trained to become professional educators, i.e. those who participated in the research described in this paper. Moreover, the tool appears fairly inconvenient since it comprises as many as 52 items.

1.1. Research gap

Despite it is commonly acknowledged that digital competence is a precondition for excellent teaching in the twenty-first century, there is a gap in the monitoring of pre-service teachers' instrumental and operational abilities which constitute digital competence. A critical topic is how teacher education programs can scan the level of these characteristics in order to assure appropriate competency in their pre-service teacher students. This question is critical for teacher education. To the authors' knowledge, validated scales that estimate digital competence in pre-service TVET teachers are non-existent in the Kazakhstani setting. At the same time, [13] developed and introduced the Digital Competence Scale for University Students (DC-US) in the Chinese population, and the construct has proven to have sound psychometric characteristics. Since pre-service TVET teachers receive training in tertiary education institutions, the scale is applicable to this contingent. The DC-US was conceived to detect digital deficiencies and is structured around two components, namely digital skills and technical literacy. The DC-US includes only ten items, which makes it non-cumbersome to administer and score in practical educational settings.

Moreover, it lowers the risk of surveyee attention span reduction, thus probably preventing measurement distortion. That is why the decision has been taken to choose the scale for this cross-sectional investigation.

1.2. Research purpose

The current study is intended to close the described research gap. To this end, the research has a two-fold objective: (a) to translate and validate the DC-US on a sample of pre-service TVET teachers in Kazakhstan, and (b) to provide a snapshot of the status quo of the students' digital competence.

2. Methodology

Following the obtainment of the approval to conduct this validation and observational study from the local Ethical Committee, a cross-sectional survey study was undertaken. The research was run in three stages: questionnaire translation (stage 1), a pilot study (stage 2), and the final form-based survey (stage 3).

2.1. Stage 1

The DC-US is originally an English instrument that implies taking a stand on ten statements, with 0 (strongly disagree) and 4 (strongly agree) as endpoints. The total scores range from 0 to 40 and higher scores indicate greater digital competence. To make administering the questionnaire in Kazakhstan possible, translation into Russian (as Russian is the overwhelming language of communication in Kazakhstan) and back translation were completed in end-August 2022, as well as an expert panel discussion. The translation was provided by a translator from the Department of English Language. The back translation was performed by a volunteer from the United States whose mother tongue is English. The panel discussed the resulting draft until an agreement was reached.

2.2. Stage 2

In early September 2022, a pilot test among 10 undergraduate students was conducted to examine whether the pre-final version was comprehensible to Kazakhstani students. No corrections were eventually required, and the draft was accepted as the final version. Table 1 lists the items in their original (English) and adapted (Russian) forms.

Table 1. Items of the Kazakh Digital Competence Scale for University Students

Original item (English)	Translated item (Russian)
DS1. I am good at sharing and collaborating with others effectively in digital learning environments.	Я умею эффективно обмениваться информацией и сотрудничать в цифровой образовательной среде.
DS2. I am confident with my capability of applying digital technologies to increase my learning effectiveness and efficiency.	Я уверен(а) в своей способности применять цифровые технологии для повышения эффективности и результативности обучения.
DS3. I can find solutions to any challenges that emerge in digitally enhanced learning.	Я могу найти решение любых проблем, возникающих в процессе обучения в цифровой среде.
DS4. I am comfortable with reading screen-based texts with concentration and persistence.	Я могу читать тексты с экрана, проявляя концентрацию и усидчивость.
DS5. I am comfortable with watching academic videos with concentration and persistence.	Я могу смотреть образовательные видеофильмы, проявляя концентрацию и усидчивость.
DS6. I set clear learning goals when using digital technologies for subject learning.	Я ставлю отчетливые цели при использовании цифровых технологий для изучения того или иного предмета.
TL1. I am fully aware of the legal and ethical issues on the use of digital technologies.	Я осведомлен(а) о правовых и этических нюансах, связанных с использованием цифровых технологий.
TL2. I have an informed and balanced attitude towards digital technologies, fully aware of their potential benefits and risks.	У меня осознанное, взвешенное отношение к цифровым технологиям: я полностью осознаю их потенциальные преимущества, как и связанные с ними риски.
TL3. I keep abreast of the latest developments of the digital technologies used for my work.	Я слежу за последними достижениями в области цифровых технологий, связанных с моей предметной областью.
TL4. I can decide on the digital technologies that are most relevant and appropriate for my study among a variety of options.	Среди множества цифровых технологий я могу выбрать наиболее актуальные и подходящие для моего обучения.

Note. DS = Digital Skills. TL = Technical literacy.

2.3. Stage 3

The decisive stage of this research was to administer the survey and process the data collected.

2.3.1. Participants and data collection

First, we needed to determine the sample size required for this survey. Given that there is no publicly available data on how many students are enrolled in undergraduate programs that train vocational educators in Kazakhstan, we had to rely on more vague boundaries. As per official statistics (new.stat.gov.kz), the number of students in higher and postgraduate education in Kazakhstan at the beginning of the 2022-2023 academic year was 578,200. Keeping the margin of error at 7%, the population proportion at 50%, and the confidence interval (CI) at 95%, the minimal sample size of 196 was calculated for this investigation through the online Raosoft sample size calculator (raosoft.com/samplesize.html). We expected at least an 80% response rate, so the number of potential surveyees should be increased by 20%, that is 39, totaling 235 questionnaires to spread. Thence, a total of 235 undergraduate students aimed at the TVET educator diploma from seven Kazakhstani universities were approached for this study using the convenience sample method. The questionnaire including socio-demographic variables was made available online and links were distributed by the research team members via electronic mail. The objectives of the survey were explained to all potential respondents. They were asked to participate voluntarily, and the enrollment followed their consent to be recruited into this study. Data were collected anonymously in a self-reported fashion. Eventually, a total of 202 students (response rate of 86%) consented to participate and filled out the questionnaire (all responses complete) over the period from mid-September to end-November 2022. The respondents (55% female) aged between 17 and 28 years, with a mean age of 21. Of them, 64 (31.7) were first-year students, 52 (25.7%) were sophomores, and 86 (42.6%) were third-year students and further; 129 (63.9%) had a rural background, and 73 (36.1%) reported an urban background.

2.3.2. Data analysis

Mean, standard deviation, skewness, and kurtosis of the survey data were computed to illustrate the dataset characteristics, including distribution symmetry considered normal if kurtosis and skewness vary from −1.5 to 1.5.

In order to examine the internal consistency of the Kazakh version of the DC-US, we used a corrected item-total correlation designed to inform the association between each item and the scale's overall score, with values >.30 deemed acceptable. In lieu of Cronbach's alpha, the first-last type of split-half approach was employed which divides the response pool into two equal parts and provides the Spearman-Brown value reflecting the correlation between these halves. This enables the internal consistency of the scale to be evaluated taking into account the number of items. The split-half criterion is interpreted in the same way as Cronbach's alpha (values above .70 indicate good internal consistency). Intercorrelations among the items were explored using a Pearson correlation matrix, with the r coefficient of zero to .29, .30 to .59, and above .60 conventionally interpreted as the low, moderate, and strong magnitude of a relationship, respectively.

To figure out the structure underlying the questionnaire (i.e., how many dimensions the actual items cluster into), look at factor loadings onto the dimensions, and test the overall model goodness-of-fit, confirmatory factor analysis (CFA) was performed with Lavaan package [14]. The analysis encompassed generating a CFA diagram that would depict a standardized structural model considered appropriate once the correlational path weights are no less than .40. For the sake of continuity between versions of the DC-US, we interpreted the CFA outcome using cut-off values mentioned in the original study [13] as follows: "(a) normed chi-square ($\chi2$/df), which ranges between 2.0 and 5.0, (b) comparative fit index (CFI) $\geq$0.90, (c) normed fit index (NFA) $\geq$0.90, (d) standardized root mean square residual (SRMR) < 0.05, and (e) root mean square error of approximation (RMSEA) $\leq$0.08." Noteworthy, given that NFI does not penalize for adding parameters to a model, its usage is discouraged for model comparisons [15], while the Tucker-Lewis index (TLI) lacking that drawback is recommended instead, with the same interpretation, so TLI was utilized in our analysis rather than NFI. The two-dimensional model of the original DC-US served as a priori basis for our factorial analysis which obviated the need for exploratory factor analysis [16]. However, the factorability of the dataset preceded CFA. To this end, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were conducted. They indicate the data adequacy for factor analysis provided that KMO >.60 and Bartlett's test yields p <.05 (significance was declared at the 0.05 level for all analyses). The data from our questionnaire met these requirements.

To identify whether or not the adapted DC-US could discern subjects perceiving their digital competence as high from those digitally incompetent, an overall scale score was calculated for each participant, then the sum scores were ranked. In our case, this produced a value range from 3 to 35. Twenty-seven percent of 35 is 9.5. Adding this number to 3 gives 12.5, and subsequently, 13 served as the lower boundary, i.e., respondents who scored a total of 13 or less were assigned to a conditional low-score group. Subtracting 9.5 from 35 gave 25.5, so individuals who scored 26 or more were grouped into a high-score subsample. Then, a between-group comparison was made for each item by means of a two-tailed independent samples t-test, and the distinctive validity of a given item was categorized as acceptable if there was a significant difference. Item infit and outfit mean square statistics were obtained using the unidimensional Rasch model to control for item bias [17], with .70-1.30 as an acceptable range signaling unidimensionality [18],[19]. All statistical analyses were carried out through the packages for R software version 4.2.1.

3. Results

After the collection and processing of participants' data, the findings are presented through five analyses, as listed below.

3.1. Descriptive statistics

Means, standard deviation (SD), and kurtosis and skewness values for the ten items of the Kazakh DC-US are displayed in Table 1. For all items, skewness and kurtosis fall within the 1.5 intervals, suggesting data symmetry.

Table 2. Descriptive statistics for the Kazakh Digital Competence Scale for University Students (n = 202)

Item	Mean (SD)	Skewness	Kurtosis
DS1	2.43 (.91)	-0.32	-0.09
DS2	2.27 (1.08)	-0.30	-0.59
DS3	2.02 (1.08)	-0.11	-0.81
DS4	2.44 (1.15)	-0.38	-0.69
DS5	2.81 (.99)	-0.72	0.14
DS6	2.39 (.95)	-0.67	0.01
TL1	1.97 (1.15)	-0.18	-0.82
TL2	2.63 (1.09)	-0.49	-0.43
TL3	2.06 (1.28)	-0.21	-1.10
TL4	2.43 (1.06)	-0.43	-0.52

Note. SD = standard deviation. DS = Digital Skills. TL = Technical literacy.

3.2. Rasch statistics

The item-fit values ranged from 0.72 to 1.29 (Table 3), which denotes that the DC-US item scores are appropriately adjusted as per the item-response prediction of the Rasch model.

Table 3. Rasch infit and outfit mean square values for the Kazakh Digital Competence Scale for University Students (n = 202)

Item	Infit	Outfit
DS1	.79	.79
DS2	1.12	1.15
DS3	1.29	1.29
DS4	1.26	1.26
DS5	.86	.88
DS6	.77	.76
TL1	1.22	1.23
TL2	.74	.78
TL3	1.11	1.11
TL4	.72	.72

Note. DS = Digital Skills. TL = Technical literacy.

3.3. Confirmatory factor analysis

CFA model-fit indices were as follows: $\chi 2/df$ = 2.036 (69.209/34), CFI = 0.968, TLI = 0.957, SRMR = 0.038, RMSEA = 0.072. Thus, the bi-factorial model met the predefined criteria. As evident from the CFA diagram (Figure 1), all the DC-US items loaded on their respective factors, and factor loadings were above the 0.4 threshold, so it is safe to claim that the survey data support the two-factor solution, although the paths for DS1 and TL1 were not statistically significant.

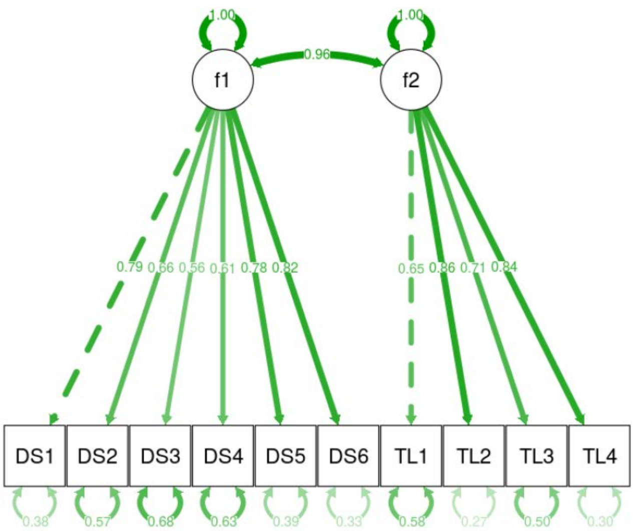

Figure 1. Graphical representation of the confirmatory factor analysis for the Kazakh Digital Competence Scale for University Students (n = 202). DS = Digital Skills. TL = Technical literacy. Rectangular boxes = measured variables. Oval boxes = latent factors.

3.4. Internal consistency

The Spearman-Brown estimate of 0.892 (CI = 0.858, 0.918) was obtained for the 10-item structure. Corrected item-total correlation ranged from 0.57 to 0.83. As supportive evidence, the correlation matrix (Figure 2) shows moderate-to-strong intercorrelations among the items.

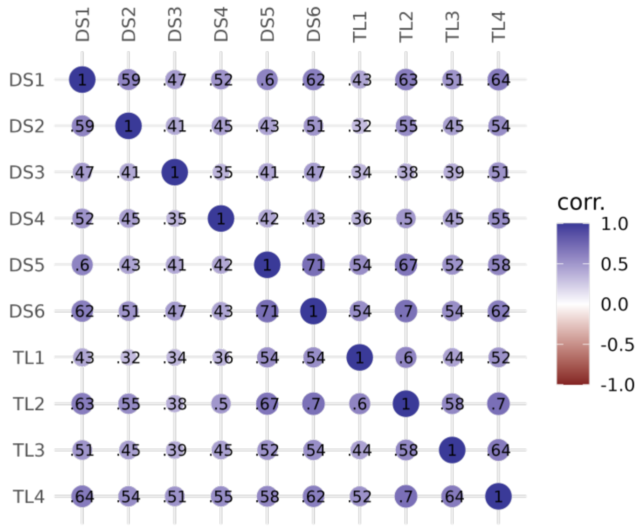

Figure 2. Pearson correlation plot for the Kazakh Digital Competence Scale for University Students (n = 202). DS = Digital Skills. TL = Technical literacy.

3.5. Distinctive validity

Table 4 demonstrates significant differences between the worst and best performing surveyees, indicating a good distinctive validity of the tool.

Table 4. Score comparison (t-test) between high-score and low-score groups for the Kazakh Digital Competence Scale for University Students (n = 124)

Item	Low-score group (n = 29), Mean (SD)	High-score group (n = 95), Mean (SD)	t	p value
DS1	1.10 (.67)	3.05 (.61)	14.736	< 0.01
DS2	.97 (.68)	2.91 (.92)	10.466	< 0.01
DS3	.76 (.64)	2.59 (.92)	10.031	< 0.01
DS4	1.10 (.72)	3.12 (.92)	10.782	< 0.01
DS5	1.34 (.86)	3.45 (.60)	14.921	< 0.01
DS6	.90 (.72)	3.02 (.50)	17.792	< 0.01
TL1	.62 (.94)	2.64 (.91)	10.387	< 0.01
TL2	1.0 (.76)	3.43 (.65)	17.023	< 0.01
TL3	.34 (.48)	2.86 (.89)	14.499	< 0.01
TL4	.72 (.53)	3.13 (.61)	19.235	< 0.01

Note. SD = standard deviation. DS = Digital Skills. TL = Technical literacy.

4. Discussion

This study intended to translate the DC-US scale to Russian, adapt it to the Kazakh context, and administer the resultant item set among the local pre-service TVET educators to validate the questionnaire and concurrently explore the students' perceptions of how digitally competent they are. All in all, the Kazakh version of the DC-US proved to be reliable as per both classic and item-response theories. The factorial modeling procedures confirmed that the Kazakh DC-US should be two-dimensional akin to the original English-language instrument. The scores obtained from the Technical literacy and Digital skills domains ranged from 1.97 to 2.81, with the overall mean equal to 2.35 (SD = 1.11), which can be construed as a medium level. The items in which students rated their competence lowest were those related to technological resourcefulness, being up-to-date with job-specific technologies, and awareness of legal and ethical matters surrounding technology usage. The top-score items were those covering the capacity to watch academic videos intently and understanding of potential benefits and risks digital technologies bear. These results may be considered consonant with previous research: academic papers that address the technology knowledge specifically in pre-service TVET teachers are negligible, but multiple survey-based investigations demonstrate pre-service teachers tend to rate their technological literacy as modest [20],[21],[22],[23],[24]. However, some exceptions to this are also present. Particularly, in a recent study [25] on 140 pre-service teachers, 77.1% of them perceived their digital competence as excellent.

The digital transformation and modification of the teaching role along with the acquisition of digital competence represent a necessity affecting all the educational spectrum [26], and TVET is no exception as TVET educators must regularly update their technological skills and possess a degree of digital competence that would enable them to make use of information and communication technologies within the teaching-learning process [27]. Indeed, the adoption of digital technology enhances the availability of education and promotes customized instructional content targeted at learners [28]. The ability to tackle non-routine and open-ended challenges appears to be expected for ongoing success in a digitalized society [29].

Competency assessment is essential for the appropriate development of the education process, and the introduction of a credible measure is of great assistance to practitioners [30].

The present study yielded a time-saving measure that university educators and administrators can easily utilize across Russian-language settings in order to get at least a rough picture of how digitally competent those who will be responsible for instructing and training students are. This could aid in determining what skills they already have and what they lack. Perhaps it would help teacher educators provide opportunities for students to boost their performance. Researchers can use the items from this version of the DC-US to construct composite questionnaires. This survey added to the research on the measurement of undergraduate student digital competence in the way that we assessed the distinctiveness of the DC-US items. Findings from the low-group versus high-group items analysis give grounds to assume that the Kazakh DC-US can discriminate between pre-service TVET instructors subjectively possessing high and low levels of digital competence.

As regards limitations, this study is restricted to Russian-speaking pre-service TVET teachers. As a future line of research, our version of the DC-US could be examined among undergraduate students of other specialties who speak other languages. Furthermore, it would be interesting to figure out how this adapted form behaves in the Russian-speaking context outside of Kazakhstan, for example, Russian higher education students. Another limitation is the original study recruited university students regardless of area, so the sample size in our study is smaller in comparison, for obvious reasons.

A promising future research direction in our view is to discover the convergence between the DC-US and an objective digital competence test. Of the standardized tests that are publicly available, we were able to find only the self-assessment tool by Digital Competences Development System (dcds-project.eu). Yet the preface to the tool states that it is intended for people with a low level of digital skills, which also follows from the content. For example, one of the items asks the respondent to indicate whether he/she would send a short message to a friend via Google Drive, WeTransfer, or WhatsApp. Obviously, such a test is not sensitive to individuals with high or even average levels of digital competence.

5. Conclusion

To sum up, the results of this study suggest that the Kazakh version of the DC-US is a sufficiently valid and reliable measure of digital competence in the pre-service TVET teacher population. The original bi-dimensional model proved to be the factor structure that fitted the data in CFA.

The study also sheds light on the current state of digital competence among pre-service TVET teachers in Kazakhstan, revealing a medium level of digital competence. We believe the potential of this scale as a quick and easy-to-use tool makes it an attractive option for educators and researchers interested in measuring digital competence among undergraduate students in other Russian-language contexts. Future research should extend the use of this questionnaire to other samples in Kazakhstan and beyond to establish its generalizability and to compare the self-reported data with an objective test for a more comprehensive evaluation. On the whole, this survey contributes to the growing body of literature on the measurement of digital competence in education and provides a valuable tool for capturing digital competence among potential TVET teachers. It is hoped that the findings of this research will inspire further research in this area and support efforts to improve the digital competence of teachers, which is becoming increasingly crucial in the modern era of technology-driven education.

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