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Cross-cultural adaptation and validation of the Internet Skills Scale in a Chinese older adult population

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Abstract: This study translated and back-translated the English version of the Internet Skills Scale (ISS) based on the Brislin translation model to develop a Chinese version of the scale. From June to December 2024, 260 older adults were recruited from the community to participate in the survey to evaluate the scale's reliability and validity. A total of 233 valid questionnaires were collected, yielding an effective response rate of 89.6%. Among the respondents, there were 121 males (52%) and 112 females (48%), with ages ranging from 60 to 90 years. The results showed that the Chinese version of the ISS consisted of four dimensions and 20 items. The Cronbach's α coefficient for the total scale was 0.862, and the Cronbach's α coefficients for the dimensions ranged from 0.705 to 0.912. Exploratory factor analysis (EFA) extracted four common factors, with a cumulative variance contribution rate of 68.533%. Confirmatory factor analysis (CFA) indicated a good model fit: $\chi^2/df = 2.26$, CFI = 0.978, IFI = 0.979, TLI = 0.974, GFI = 0.991, RMSEA = 0.074. For convergent validity, the composite reliability (CR) values were 0.932, 0.853, 0.795, and 0.88, respectively, and the average variance extracted (AVE) values were 0.734, 0.596, 0.511, and 0.616, respectively. These findings indicate that the scale demonstrates reliability and validity, making it an effective tool for assessing the digital competence of older adults.

***Keywords*:** digital competence, reliability, validity, older adults

1. Introduction

With the rapid advancement of the internet industry in China, the internet has become a vital platform for people to access information and healthcare services. In particular, younger generations have increasingly relied on online channels to obtain health-related data and professional medical support. However, China's large older adult population continues to experience a significant gap in internet adoption, which has led to a pronounced digital divide—a major social challenge—even as this group begins to benefit from digital convenience. This issue not only impacts older adults' physical and mental well-being but also considerably limits their social participation and overall quality of life (*1,2*). The persistent digital divide poses substantial barriers for older adults in accessing and using health information, medical services, and online communication tools (*3*). A lack of digital literacy also increases their vulnerability to online risks such as fraud and privacy breaches. During the COVID-19 pandemic, in particular, many older individuals struggled to access timely pandemic-related information and preventive measures due to low digital literacy and insufficient internet infrastructure. As a result, what began as a public health crisis further exposed and intensified the isolation of older adults in terms of information access (*4-6*). Studies indicate that a widening digital divide not only deepens disparities in information acquisition and usage among the older adults but also exerts long-term effects on their health and psychosocial well-being (*1,7,8*). Delayed or inadequate access to health information may undermine older adults' ability to manage their health effectively and respond to public health emergencies. Moreover, limited digital engagement reduces opportunities for social involvement and cultural participation, thereby diminishing life satisfaction (*9*).

China's aging process is characterized by unique developmental patterns and distinct transitional phases, highlighting the need to understand the relationship between digital exclusion and active aging. Building a digitally inclusive environment for older adults is not only a crucial social development goal but also a key strategy for addressing the challenges of population aging. To achieve this, it is essential to accurately and scientifically assess the digital capabilities of the older

adults, thereby providing an evidence base for policy and intervention.

Although the Chinese government has launched multiple initiatives—such as digital skill training programs and age-friendly adaptation of internet applications—to improve digital literacy among older adults (*10*), the evaluation of internet skills in this population remains underdeveloped. There is a notable absence of validated and reliable assessment tools, which hinders the effectiveness and monitoring of related interventions. Internationally, the ISS, developed by van Deursen and Helsper in 2016, is widely used to measure individuals' internet proficiency (*11*). However, its applicability to the sociocultural context and practical needs of Chinese older adults had not yet been established through rigorous translation and validation.

In response, this research team obtained official authorization to adapt the original English version of the ISS into Chinese. Through a systematic translation and cultural validation process, we developed a Chinese version of the scale and evaluated its psychometric properties. This study aims to fill the gap in validated assessment tools for digital literacy among older adults in China and to provide a robust instrument for future research and intervention in this field.

2. Materials and Methods

2.1. Questionnaire overview

The ISS is designed to measure an individual's ability to utilize the internet. Its development is based on an in-depth understanding and empirical research of internet skills, with the aim of providing a standardized tool to evaluate an individual's operational, information navigation, social, and creative skills in an online environment. The scale consists of 20 items divided into four dimensions: operational skills, information navigation skills, social skills, and creative skills. A 4-point Likert scale is used for scoring, where "does not describe me at all" is assigned 1 point and "describes me very well" is assigned 4 points.

2.2. Scale localization

To ensure the accuracy, cultural appropriateness, and psychometric properties of the translated scale, this study strictly followed the Brislin translation model. The localization of the ISS was carried out in three stages: forward translation, back translation, and cultural adaptation with consensus building.

2.2.1. Forward translation

In the forward translation stage, two bilingual translators with a medical background (both holding a master's degree or above, with over five years of experience in geriatric medicine and training in psychometrics) independently translated the original English scale into Chinese. Based on thorough discussion, they integrated their translations to form a preliminary Chinese version.

2.2.2. Back translation

In the back translation stage, two postgraduate students majoring in English who had no prior exposure to the original scale (both holding a TEM-8 certificate and possessing translation experience) independently back-translated the preliminary Chinese version into English. Subsequently, a review panel consisting of four interdisciplinary experts (covering the fields of geriatric medicine, clinical psychology, applied linguistics, and psychometrics) conducted an item-by-item comparison of the original scale, the forward-translated version, and the back-translated versions. The evaluation focused on semantic equivalence, linguistic expression, and cultural appropriateness. Items with discrepancies were revised following discussion among the expert panel and consultation with the original scale developer, ultimately resulting in a consensus version of the Chinese version of the ISS. This process ensured that the scale retained its original structure and meaning while aligning with the linguistic habits and cultural context of the Chinese older adult population.

2.2.3. Pilot survey

Using convenience sampling, 30 older adults who met the inclusion and exclusion criteria were selected. The Chinese version 2 of the ISS was distributed. The purpose of the survey and precautions were explained to the participants, and the questionnaires were collected immediately after completion. Participants were asked whether they fully understood the meaning of each item, whether each option was clear and unambiguous, and for any other questions or suggestions. After compiling, reviewing, and revising the feedback, the final Chinese version of the ISS was formed.

2.3. Reliability and validity testing of the Chinese version of the ISS

2.3.1. Study participants

A total of 260 older adult participants were recruited from the community for this survey. Inclusion criteria: aged 60 years or above, regardless of gender, and voluntarily participating in this study; able to complete the questionnaire independently or with assistance from the researcher. Exclusion criteria: individuals with severe physical illnesses or mental disorders; those who are illiterate or have a level of education too low to complete the questionnaire. After obtaining informed consent from all participants, the purpose and main

content of the study were explained using a standardized instruction script. Participants were also informed of considerations for completing the questionnaire and were provided with the Chinese version of the ISS. According to requirements for reliability and validity testing of questionnaires (*12*), a sample size of 5–10 times the number of items is necessary to achieve stable parameter estimates. The Chinese version of the ISS contains 20 items. Accounting for a 20% attrition rate, the minimum required sample size was 150. In accordance with factor analysis principles, a stable model requires a sample size of at least 200. Therefore, 233 participants were ultimately included.

2.3.2. Statistical methods

2.3.2.1. Item analysis

SPSS 26.0 was used for item analysis. The critical ratio method was applied to divide participants into high- and low-scoring groups: *i*) Discrimination analysis: All valid participants were ranked in descending order based on their total scale scores (after reverse scoring). The top 27% of participants were assigned to the high-scoring group, the bottom 27% to the low-scoring group, and the middle group was excluded. The Shapiro-Wilk test was used to assess the normality of item scores between the two groups. If the data were not normally distributed, the Mann-Whitney *U* rank sum test was performed; if the data were normally distributed, an independent samples *t*-test was conducted. An item was considered to have good discrimination if $p < 0.05$. *ii*) Homogeneity analysis: Using all valid samples, Spearman's rank correlation analysis was applied to calculate the correlation coefficient between each item score and the total scale score. An item was considered to have good homogeneity with the overall measurement objective of the scale if the correlation coefficient $r \geq 0.30$ and $p < 0.05$. Based on the results of discrimination and homogeneity analyses, items meeting the criteria were retained for subsequent factor analysis.

2.3.2.2. Reliability analysis

Internal consistency of the ISS was measured using Cronbach's α coefficient. The following criteria were applied: Cronbach's $\alpha < 0.65$ was considered poor, 0.65–0.7 as minimally acceptable, 0.7–0.8 as good, and 0.8–0.9 as excellent.

2.3.2.3. Validity analysis

i) EFA: EFA was performed on the questionnaire using SPSS 26.0. Common factors with eigenvalues > 1 were extracted using the principal component method. A cumulative variance contribution rate > 50% was considered acceptable. Orthogonal rotation (varimax) was applied to adjust the factor loadings of each item on the corresponding common factor. A factor loading ≥ 0.4 indicated good structural validity.

ii) CFA: CFA was conducted using AMOS 28.0 to evaluate the model fit. The following fit indices were used: the ratio of chi-square to degrees of freedom (χ^2/df) between 1 and 3, comparative fit index (CFI), incremental fit index (IFI), and Tucker-Lewis index (TLI) > 0.90, and root mean square error of approximation (RMSEA) < 0.08, indicating a good model fit.

Convergent validity was assessed using CR and AVE. A CR value > 0.7 and an AVE value > 0.5 for each dimension indicated good convergent validity (*13,14*). Discriminant validity refers to the distinctiveness between dimensions. Correlations between dimensions were compared using correlation coefficients, while the internal correlation of each dimension was calculated using the square root of the AVE. Discriminant validity was considered satisfactory when the internal correlation of items within a dimension was greater than the correlation between that dimension and other dimensions.

2.4. Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Shanghai University of Medicine and Health Sciences (370683199710016823-SHUTCM). This trial was registered at *https://www.chictr.org.cn/* with registry number ChiCTR2500101978, registry date 2025-05-06. All participants were informed and volunteered to participate in the study and signed a written consent form.

3. Results

3.1. Demographic characteristics of participants

A total of 260 questionnaires were distributed, and 233 valid responses were collected, resulting in a valid response rate of 89.6%. Among the participants, 121 (52%) were male and 112 (48%) were female, with ages ranging from 60 to 90 years.

3.2. Item analysis results

Using the critical ratio method, participants were divided into a low-scoring group ($n = 65$) and a high-scoring group ($n = 70$). The Shapiro-Wilk test indicated that the total scores of the two groups were not normally distributed; therefore, the Mann-Whitney *U* rank sum test was used for between-group comparisons. The results showed that the rank mean of the total score in the high-scoring group (100.50) was significantly higher than that in the low-scoring group (33.00), with $Z = -10.026$, $p < 0.001$, indicating a highly statistically significant difference and confirming the validity of the grouping.

The correlation coefficients between each item score and the total score were used as indicators for item analysis. The results showed that the correlation coefficients for the 20 items ranged from 0.353 to 0.675, all reaching statistical significance ($p < 0.05$) (Table 1).

3.3. Reliability analysis

A Cronbach's α coefficient greater than 0.8 indicates good reliability of the scale. The overall Cronbach's α coefficient of the Chinese version of the ISS was 0.862, and the Cronbach's α coefficients for the four dimensions were 0.912, 0.705, 0.818, and 0.858, respectively, indicating good internal consistency of the questionnaire (Table 2).

Table 1. Rank sum test for differences between high- and low-scoring groups and correlation with total score for items of the Chinese version of the Internet Skills Scale (ISS)

Items	Contents	Rank Mean		*U*	*Z*	*p*	*r*
		Low-scoring group ($n = 65$)	High-scoring group ($n = 70$)				
Item 1	I know how to open downloaded files	44.02	90.27	716.00	-7.033	< 0.001	0.556
Item 2	I know how to download/save photos I find online	47.15	87.36	920	-6.157	< 0.001	0.513
Item 3	I know how to use keyboard shortcuts (*e.g.*, CTRL-C to copy, CTRL-S to save)	42.19	91.96	597.5	-7.551	< 0.001	0.568
Item 4	I know how to open a new tab in the browser	45.42	88.96	807.5	-6.627	< 0.001	0.508
Item 5	I know how to bookmark a website	42.95	91.26	646.5	-7.356	< 0.001	0.554
Item 6	I find it difficult to decide which keywords to use for online searches*	38.85	95.06	380.5	-8.529	< 0.001	0.657
Item 7	I find it difficult to find websites I have visited before*	54.93	80.14	1425.5	-3.823	< 0.001	0.398
Item 8	I feel tired when searching for information online*	51.51	83.31	1203	-4.835	< 0.001	0.369
Item 9	Sometimes I don't know how I ended up on a particular website*	52.45	82.44	1264	-4.562	< 0.001	0.353
Item 10	I find many websites confusing in their design*	57.17	78.06	1571	-3.170	< 0.005	0.384
Item 11	I know what information I should and should not share online	49.32	85.34	1061	-5.553	< 0.001	0.405
Item 12	I know when to share information and when not to	46.18	88.26	856.5	-6.476	< 0.001	0.465
Item 13	I am careful with my online comments and behavior to ensure they suit the context	45.46	88.93	810	-6.721	< 0.001	0.487
Item 14	I know how to change the audience for content I share (*e.g.*, friends, friends of friends, or the public)	38.98	94.95	388.5	-8.550	< 0.001	0.670
Item 15	I know how to delete a friend from my contact list	40.72	93.34	501.5	-8.090	< 0.001	0.670
Item 16	I know how to create something new using existing online images, music, or videos	40.08	93.93	460	-8.158	< 0.001	0.642
Item 17	I know how to make basic modifications to content created by others	38.32	95.56	346	-8.691	< 0.001	0.675
Item 18	I know how to design a website	50.19	84.84	1117.5	-5.558	< 0.001	0.414
Item 19	I know about different types of licenses applicable to online content	41.92	92.22	579.5	-7.858	< 0.001	0.586
Item 20	I am confident in putting video content I have created online	41.64	92.48	561.5	-7.812	< 0.001	0.564
Total score		33.00	100.50	< 0.001	10.026	< 0.001	1.000

*denotes a reverse scoring question.

3.4. Validity analysis

3.4.1. EFA

The suitability test for factor analysis indicated a KMO index of 0.83 and a Bartlett's test of sphericity with $p < 0.001$, suggesting that the data were appropriate for factor analysis. Using varimax orthogonal rotation, four common factors with eigenvalues greater than 1 were extracted. The cumulative variance contribution rates for Factors 1 to 4 were 29.520%, 47.137%, 59.616%, and 68.533%, respectively. The EFA results showed that the factor loadings of all items on the common factors ranged from 0.600 to 0.894, all exceeding the threshold of 0.4, indicating good structural validity of the questionnaire. The rotated factor loading matrix is presented in Table 3.

3.4.2. CFA

AMOS software was used to conduct CFA on the questionnaire, and model parameters were estimated using the maximum likelihood (ML) method. The CFA model of the Chinese version of the ISS is shown in Figure 1. The model fit indices are presented in Table 4.

Table 2. Overall Cronbach's α coefficient and Cronbach's α coefficients for each dimension of the Chinese version of the Internet Skills Scale (ISS)

Factors	Cronbach's α coefficients
Operational	0.912
Information Navigation	0.705
Social	0.818
Creative	0.858
Overall	0.862

The results showed a good model fit: $\chi^2/df = 2.26$, CFI = 0.978, IFI = 0.979, TLI = 0.974, GFI = 0.991, and RMSEA = 0.074. For convergent validity, the CR values were 0.932, 0.853, 0.795, and 0.880, respectively, and the AVE values were 0.734, 0.596, 0.511, and 0.616, respectively, indicating good convergence for each dimension of the questionnaire. The standardized factor loadings for each item are shown in Table 5.

4. Discussion

With the increasing aging of the population and rapid development of digital technology in China, the digital divide has become a critical issue affecting social participation and quality of life among older adults. Currently, internet usage is an important indicator reflecting the digital divide (*1,15*). A significant negative correlation exists between the digital divide among older adults and active aging in China—the wider the digital gap between older and younger generations, the lower the level of active aging among the older adult population, making it more difficult for them to fully benefit from the digital era (*16*). Research by Mariska *et al.* (*17*) demonstrated a close relationship between internet use and self-management abilities among older adults. Digital participation increases opportunities for meaningful engagement with friends and family, leading to higher life satisfaction, lower levels of depression, and reduced loneliness. Some scholars argue that older adults can acquire more health knowledge through the internet, thereby improving physical health (*18,19*). Internet use can also alleviate loneliness among older adults (*20*), thus promoting mental well-being, and supporting psychological health through continued learning (*21-*

Table 3. Factor loadings and communalities from principal component analysis of the Chinese version of the Internet Skills Scale (ISS)

Factors	Items	Factor Loading				Communality
		Operational	Information Navigation	Social	Creative	
Operational	1	0.831				0.725
	2	0.775				0.639
	3	0.853				0.748
	4	0.894				0.811
	5	0.878				0.789
Information Navigation	6		0.684			0.835
	7		0.709			0.525
	8		0.815			0.672
	9		0.836			0.735
	10		0.749			0.659
Social	11			0.821		0.731
	12			0.815		0.704
	13			0.766		0.609
	14			0.600		0.606
	15			0.581		0.600
Creative	16				0.683	0.610
	17				0.774	0.698
	18				0.774	0.654
	19				0.824	0.724
	20				0.781	0.635

23). Based on the aforementioned research background and practical needs, this study aims to conduct a cross-cultural validation of the ISS among the Chinese population and evaluate its psychometric properties. This not only provides a reliable tool for scientifically assessing the digital competence of older adults but also offers a solid empirical basis for the development of relevant interventions and policies.

This study conducted a systematic reliability and validity test of the Chinese version of the ISS, and the results indicated that the scale demonstrated good psychometric properties in the Chinese sample. Item analysis showed that the difference in total scores between the high- and low-scoring groups was highly statistically significant, and the correlation coefficients between each item and the total score were at a moderate level or above, suggesting that the items had good discrimination. This finding is consistent with previous studies reporting high discrimination of the ISS items, indicating that the scale can effectively capture differences in individuals' internet skill levels across different cultural contexts (*24*).

In terms of reliability, the overall Cronbach's α coefficient of the scale in this study was 0.862, and the coefficients for the dimensions ranged from 0.705 to 0.912, all reaching acceptable levels, indicating that the scale has good internal consistency. Previous studies have also shown that this type of ISS typically demonstrates reliability levels above 0.70 across samples from different countries (*24*), and the results of this study are generally consistent with those findings.

In terms of construct validity, this study extracted four common factors through EFA, with a cumulative variance contribution rate of 68.533%. The factor loadings for each item on its corresponding factor were above 0.6, indicating that the scale has a clear factor structure. This four-factor structure is highly consistent with the classic internet skills framework proposed by van Deursen *et al.* (*25*). Previous studies conducted in countries such as the Netherlands have also validated the stability of this four-dimensional structure and noted that the framework effectively captures the hierarchical nature of individuals' skills, ranging from basic operational skills to higher-order information utilization

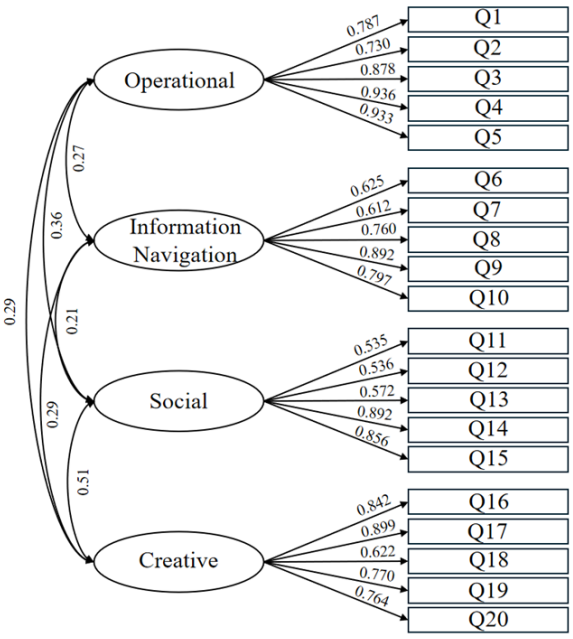

Figure 1. Confirmatory factor analysis model of the Chinese version of the Internet Skills Scale (ISS). This study constructed a confirmatory factor analysis model comprising four latent variables: "Operational", "Information Navigation", "Social", and "Creative". Each latent variable was measured by its corresponding observed variables (Q1–Q20). As shown in Figure 1, the standardized factor loadings of all observed variables on their respective latent variables were positive, ranging from 0.535 to 0.936. Specifically, the factor loadings for items in the "Operational" dimension ranged from 0.730 to 0.936; those in the "Information Navigation" dimension ranged from 0.612 to 0.892; those in the "Social" dimension ranged from 0.535 to 0.892; and those in the "Creative" dimension ranged from 0.622 to 0.899. All items met or exceeded the recommended threshold of 0.50, indicating that the scale overall demonstrated good construct validity. In addition, there were moderate correlations among the latent variables, suggesting that while the dimensions are distinct, they are also interrelated, which is consistent with theoretical expectations.

Table 5. Standardized factor loadings for each item of the Chinese version of the Internet Skills Scale (ISS)

Factors	Items	Standardized Factor Loadings
Operational	1	0.788
	2	0.729
	3	0.878
	4	0.935
	5	0.934
Information Navigation	6	0.971
	7	0.480
	8	0.634
	9	0.763
	10	0.648
Social	11	0.901
	12	0.955
	13	0.666
	14	0.838
	15	0.795
Creative	16	0.851
	17	0.893
	18	0.605
	19	0.770
	20	0.769

Table 4. Results of confirmatory factor analysis for the Chinese version of the Internet Skills Scale (ISS)

Fit Index	χ^2/df	RMSEA	CFI	IFI	TLI	GFI
Recommended Threshold	< 3.000	< 0.08	> 0.900	> 0.900	> 0.900	> 0.900
Model Result	2.26	0.074	0.978	0.979	0.974	0.991

(*24*). The results of this study replicated this structure within a Chinese sample, suggesting that the theoretical model has a certain degree of cross-cultural applicability.

It is noteworthy that subsequent developments of the ISS have proposed an expanded five-dimensional structure that additionally incorporates mobile skills (*11*). In the present study, this dimension was not included, which may be related to both the version of the scale adopted and the characteristics of the target population. Compared with younger populations, older adults may rely less on mobile-specific functions or exhibit different patterns of technology use. Therefore, future research could further examine whether incorporating mobile skills would improve the explanatory power of the scale in the context of rapidly evolving digital environments in China.

The results of CFA further supported the reasonableness of the scale's structure. The model fit indices in this study (χ^2/df = 2.26, CFI, TLI, *etc.* > 0.95, RMSEA = 0.074) met or approached the recommended thresholds, indicating that the four-factor model demonstrated good fit. Additionally, the CR values for all dimensions were above 0.7, and the AVE values exceeded 0.5, showing good convergent validity. These findings are consistent with previous studies that reported good structural stability of the ISS across samples from multiple countries, further confirming the applicability of this scale in the Chinese context.

It is worth noting that the measurement results of internet skills may be influenced by various factors across different cultural contexts. On the one hand, the Chinese internet environment is characterized by significant platform centralization, which may reduce the demands on "information navigation skills" to some extent while reinforcing the importance of "operational skills". On the other hand, Chinese users tend to rely more heavily on algorithmic recommendations and social dissemination during information retrieval, which may affect the performance of information skills and strategic skills. Moreover, factors such as generational differences, educational background, and the stage of digital development are also considered to influence the developmental levels of different skill dimensions. Previous research has pointed out that operational and formal skills rely more on experiential accumulation, whereas information and strategic skills depend more on cognitive ability and educational level (*25*), a conclusion that also holds explanatory power in the Chinese context.

This study has several limitations. In terms of sample acquisition, a convenience sampling method was employed. Although this approach is feasible in practice, it may introduce selection bias and thus affect the generalizability of the findings. Second, the study participants were primarily drawn from specific regions, resulting in certain geographical limitations in the sample distribution, which may not fully capture differences in internet usage environments and skill structures across populations from different areas. The data in this study relied mainly on self-reports from participants, which may have been influenced by social desirability bias and individual subjective perceptions, potentially introducing some degree of measurement interference. In addition, although the sample size met the requirements for statistical analysis, the overall representativeness remained relatively limited, particularly with respect to potential imbalances in age structure, educational level, and other demographic characteristics. Therefore, future research should adopt stratified random sampling methods across a broader scope, expand the geographical and population coverage of the sample, and incorporate objective behavioral data or situational assessment methods to further improve the stability and generalizability of the measurement results, thereby enabling a more comprehensive evaluation of the structural characteristics of internet skills across different populations.

5. Conclusions

In summary, this study validated the four-factor structure of the ISS and its reliability and validity within a Chinese sample, and found that this structure demonstrated good stability in cross-cultural comparisons. This not only provides a reliable measurement tool for digital divide research in China but also enhances the comparability of the ISS across different cultural contexts. Future research could further examine whether the scale exhibits the same structure and meaning across groups differing in gender, age, educational level, and urban–rural residency, thereby enabling a more precise analysis of digital inequality in the Chinese context.

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