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Validation of a scale based on the DigComp framework on internet navigation and cybersecurity in older adults

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The global COVID-19 pandemic revealed the persistence of the digital divide in older adults. The need to use technologies in order to communicate, remain informed and have contact with society, along with the need to perform online transactions, led to increased susceptibility, given the potential for scams and cyberattacks. This was a cause of concern amongst the general population, and especially amongst the elderly. The aim of this study is to validate a useful and reliable scale that measures the digital literacy of the senior population. This literacy refers to how they safely search for and manage information, as well as their competencies with regard to the security of their own devices. This scale was created through the adaptation of competencies 1.1, which consist of "browsing, searching and data filtering," as well as 4.1, which considers "protecting devices," from the DigComp model. The quantitative and qualitative analyses have required three samples: (1) a group of experts ($N = 20$) to adapt the scale to the Active Aging Model, (2) a group of older adults ($N = 50$) to carry out the exploratory factor analysis and (3) another group of older adults ($N = 174$) for the confirmatory factor analysis. The results of the analysis reveal the validity and reliability of the designed scale. To conclude, on one hand, the proposed model reveals a goodness of fit; on the other hand, older adults continue to demonstrate a reluctance to use the technologies for financial dealings. In this study, we present a new and reliable instrument adapted to the digital needs of seniors, which can be used by organizations and administrations to promote support policies and training activities for older adults within the active aging framework.

KEYWORDS

cybersecurity, cyberattacks, senior population, scale validation, DigComp

1 Introduction

Living in the information, communication, and knowledge society, connectivity and internet access have become essential for the global population. Not all citizens have the same accessibility or sufficient skill to use the internet appropriately. Thus, the digital divide remains a current challenge (Gómez et al., 2018), specifically a difficult issue to address in the age group identified as older adults (55+ years). The causes are varied: these individuals tend to have less knowledge of information and communication technologies (ICT) compared to other groups, which creates a certain resistance to the unfamiliar. Additionally, their visual and cognitive abilities decline, resulting in a less agile use of devices.

Moreover, the global COVID-19 pandemic highlighted the persistence of the digital divide among older adults. Indeed, the exclusion they experienced in digital participation spaces (Seifert et al., 2021) became evident, both due to their lack of familiarity and their limited proficiency in specific digital skills (Kwiatkowska and Skórzewska-Amberg, 2019). This prevented them from integrating into a society that, within days, became hyper-technologized. In this society, the urgent need to use technologies to stay informed and communicate with others (family, friends, etc.) emerged, as well as the need to conduct online transactions, increasing their vulnerability to potential fraud and cyberattacks (Morrison et al., 2020). Notably, Interpol (2020) had already warned of the alarming rise in cyberattacks during the COVID-19 pandemic. All of this has generated concern among the general population, especially among older adults.

This group faced the surge in the use of digital devices and applications for social interactions, as well as with public administrations and businesses during the pandemic, with the help of family members and with much insecurity and uncertainty about digital self-protection against fraud and cyberattacks.

While it is true that the unfolding events took governments by surprise, and we observed decision-making that was, at times, erratic in different places and moments (Gómez, 2023; Inácio et al., 2021), it is equally true that they are obligated, within their social responsibility, along with other social organizations (educational and training centers, etc.), to establish channels to help their citizens address these issues. Initially, this involves ensuring access to and use of technologies, followed by improving digital skills for effective and critical usage (von Solms and van Niekerk, 2013).

Older adults indeed exhibit certain digital vulnerabilities, putting both their financial resources and personal data at risk, which limits their independence and autonomy. However, it is also undeniable that ICT can help promote active aging, and with specific training, it is possible to reduce the digital divide and improve their quality of life.

In this regard, the European Commission has designed the European Digital Competence Framework (DigComp), establishing a detailed standard for developing digital competence among all European citizens. DigComp helps measure and improve individuals' digital skills, knowledge, understanding, and competencies, and it can serve as a resource for planning and developing digital training programs. To achieve this, it would be helpful to identify the actual needs regarding safe information searching and management online, as well as to promote increased device security skills among older adults.

1.1 Safe browsing, searching, and filtering of online data

For our digital society to be inclusive and fulfilling, it is essential that older adults understand the processes and resources linked to the internet, allowing them to browse, search for information, use email and chats, and engage with social media safely. The European Commission (2018a) has already established the Digital Education Action Plan, providing specific guidelines to promote more efficient use of digital technologies and encourage digital skills training for European citizens across all stages of life (European Commission, 2018b).

Encouraging older adults to integrate technology into their daily lives can indeed be beneficial (Burdick and Kwon, 2004; Chan et al., 2016), as demonstrated by the COVID-19 pandemic (Doraiswamy et al., 2020; Drazich et al., 2023; Elliot et al., 2014). In this context, Schroeder et al. (2023) identified 119 factors influencing this group's intention to use technology. However, it is also common for older adults to experience difficulties using new devices, citing a lack of information and support for usage (Vaportzis et al., 2017), and often possessing lower levels of digital competence for information searching and processing compared to younger individuals (Amaro et al., 2020). Older adults themselves are aware of these usage limitations, acknowledging the need for training and guidance to help them respond effectively to increasingly technological challenges (Goher et al., 2017; Rogers et al., 2022).

For several years, research on older adults and internet use has indicated that this group is increasingly familiar with it, showing significant, though varied, levels of use (Mitzner et al., 2010; Bergström, 2023; Leukel et al., 2021; van Boekel et al., 2017). Hargittai et al. (2019) note that internet usage and knowledge within this group vary widely, influenced by socioeconomic status and autonomy in use. In a quantitative literature review, Hunsaker and Hargittai (2018) identified trends in access, skills, and types of use, while exploring social inequalities in each domain. However, some studies point to the need for accurately evaluating models explaining internet use among older adults, as gaps in this area are being identified (Leukel et al., 2024).

Due to the increased use of digital devices for economic transactions, not only basic ones, and the decreasing use of cash, everyone is at risk of falling victim to cybercriminals. Our lack of knowledge makes it possible to suffer such crimes without even realizing it (von Solms and van Niekerk, 2013). In this regard, safe web browsing is one of the primary concerns for older adults (Kisekka et al., 2015), with high levels of vulnerability identified (Zou et al., 2024). Older adults tend to view themselves as less tech-savvy compared to other age groups and more likely to fall for spam emails (Grimes et al., 2007). Their heightened concern for privacy often leads them to rely on proxies to manage their digital activities (Bartol et al., 2024), especially after experiences of identity theft (Watson et al., 2018) or financial crimes (Burton et al., 2022).

1.2 Security and protection of personal digital devices

Digital transformation will not be possible without cybersecurity (Möller, 2023). Therefore, fostering citizens' digital trust is a complex challenge; it pertains to the sense of security that individuals feel when sharing personal data, intimate and family images, conducting economic transactions of any kind, and using digital services.

Trust is built on several factors, such as privacy, security, transparency, and the accountability of organizations that handle our data. To achieve this, critical digital literacy is essential, along with basic digital skills and an awareness of potential risks, avoiding being swayed by rumors and fake news. Currently, we have regulations regarding data protection and transparency, which entail severe penalties for organizations that violate this legislation. It is also necessary to have secure infrastructures that protect systems by promoting robust technical standards that ensure security in communications (Agencia Española de Protección de Datos–AEPD, 2024).

Cybersecurity is the practice of protecting devices, networks, and personal data; therefore, it is an essential skill in the digital age. Organizations such as INCIBE have been established to promote digital trust among citizens, as we must be aware of the risks and know how to protect ourselves from potential cyberattacks. Older adults are no exception.

According to the Financial Digitalization Observatory [Observatorio de la Digitalización Financiera (ODF) Funcas-KPMG, 2023], 70% of the Spanish population uses online banking, and this number is increasing. As a result, many financial services have transitioned to digital platforms, often not allowing any alternatives, thus forcing people to use their applications on their own devices. Therefore, with the rise in the use of digital devices for administrative and financial tasks, everyone is at risk of falling victim to cybercriminals.

However, focusing on this group, the risks increase due to their lower familiarity with technology, which leads to greater difficulties in identifying threats and adopting security measures. Some studies (Agencia Española de Protección de Datos–AEPD, 2024) highlight that a significant percentage of older adults avoid online activities due to concerns about potential fraud. This fear can limit their ability to take advantage of the benefits that the internet offers (von Solms and van Niekerk, 2013).

Spain is one of the countries with the highest rate of cybercrime in Europe. According to the latest crime reports published by Europol (2024) and the Ministerio del interior (2023), the rise in cybercrimes in recent years is concerning. Considering that mobile devices are becoming increasingly popular, ensuring security on digital devices is essential to prevent the loss of sensitive personal information, such as passwords, medical data, or banking details.

To address this reality, it is necessary to understand the basic concepts of cybersecurity and to be aware of the tactics used by cybercriminals. Older adults can protect their personal information and enjoy a safer online experience if they are trained to do so. As a result, certain public organizations support initiatives where training on this topic is a priority. In Spain, the National Cybersecurity Institute (INCIBE) has a specific program called #Experienciasenior. In the U.S., data released by the PEW Research Center (McClain et al., 2023) acknowledges that digital competence among citizens is essential for addressing concerns related to privacy and the security of their personal data.

1.3 Evaluation of digital competence

Broadly, digital competence can be understood as the set of knowledge, skills, and abilities that enables a person to use information and communication technologies safely and efficiently (van Dijk and van Deursen, 2014). Since 2013, the European Commission has established a framework called DigComp that identifies and defines the digital competencies that citizens in general, across its member countries, should possess (Ferrari, 2013). This model has evolved over the past decade (Carretero et al., 2017; Vuorikari et al., 2016, 2022a), establishing 21 competencies grouped into five areas, which identify eight levels of achievement.

In addition to all of this, the European Union has been implementing processes for evaluating and measuring competencies since 2014, utilizing updated methodologies and the Digital Competence Indicator (ICD) (Vuorikari et al., 2022b). However, from our perspective, considering the characteristics of older adults, there is a need to adapt the existing assessment tools.

Thus, with more direct and straightforward wording, incorporating questions related to the daily lives of older adults and presenting a format that is more intuitive and aligned with their cognitive abilities -considering that physical and sensory deterioration often leads to difficulties in understanding certain issues or visualizing the assessment tool- we have created an instrument to evaluate the digital competencies of this group. Therefore, the objective of this work is to validate a useful and reliable scale that measures the digital competencies related to information searching and management (1.1), as well as competencies related to cybersecurity (4.1) among older adults.

2 Methods

This study was conducted during the academic year 2023–2024 in a digital literacy workshop, which is part of an interuniversity project focused on digital competence. An exploratory, non-experimental, cross-sectional design was employed. The research approach integrated both quantitative and qualitative methods, utilizing content review through expert opinions and complementing it with descriptive statistical analyses, exploratory factor analysis (EFA), and confirmatory factor analysis (CFA).

2.1 Procedure

The research was conducted in 7 clearly defined but interdependent phases (Figure 1).

Phase 1: Adaptation of DigComp. First version of the scale. Following a thorough literature review and the search for validated and reliable instruments on the topic, the digital competencies related to "navigating, searching, and filtering data" (1.1) and those related to "protecting devices" (4.1) from DigComp were specified. The selection of these two competencies is based on the foundations of the aging model (Rowe and Kahn, 1987, 1997), which identifies engagement in life through personal relationships and meaningful activities as a factor of social wellbeing.

For each competency, the first four levels of proficiency from the eight outlined in DigComp were considered: the basic levels (1 and 2) and the intermediate levels (3 and 4), as these are the levels most commonly exhibited by older adults according to the results obtained by the Observatorio Nacional de Tecnología y Sociedad (2024) and other research (Bunbury et al., 2022). The wording of each situation involved a meticulous process, ensuring the use of appropriate language for comprehension and understanding by the participants.

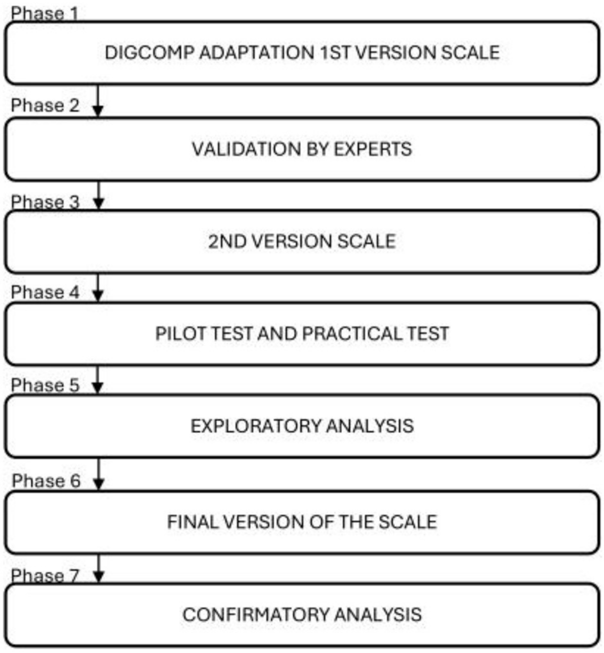

FIGURE 1
Phases of the research. Created by the authors.

Phase 2: Expert Validation. The content validation was carried out through a panel of experts using a Delphi methodology, verifying whether the proposed situations in the scale were understandable, correctly formulated, and accurately reflected what was intended to be evaluated.

Phase 3: Second Version of the Scale. Following the analyses described, an improved version of the scale was developed based on the results of the previous phase.

Phase 4: Pilot Test. To determine criterion-related validity and assess whether the scale provides a valid and comprehensive measurement of digital competencies, practical tests associated with the competencies to be measured were included (van Deursen and van Dijk, 2009). The pilot test was conducted in two stages: (a) the application of the scale, and (b) the execution of practical tests related to digital skills competencies. The time taken to complete both tasks was monitored.

Phase 5: Exploratory Analysis. Through exploratory factor analysis (EFA), internal validity or construct validity was determined. To achieve this, data obtained from the pilot test were used, and the Omega statistic was calculated (Ventura-León and Caycho-Rodríguez, 2017). To assess criterion-related validity or external validity, the Spearman correlation coefficient was computed (van Deursen and van Dijk, 2009).

Phase 6: Final Version of the Scale. After adjusting the items based on the results of the previous tests, the final version of the scale was obtained.

Phase 7: Confirmatory Analysis. A structural equation modeling (SEM) study was conducted to test whether the set of observed variables represented a series of underlying latent constructs or factors through confirmatory factor analysis (CFA).

2.2 Participants

The information was collected at three successive points with three different groups of participants:

- Expert Judgment: A group of 20 experts was convened, consisting of 10 men and 10 women. The selection of participants was intentional, inviting individuals with experience and knowledge in areas such as educational technology, digital literacy, and adult education. These experts have backgrounds in Pedagogy, Psychology, Health Sciences, Information Systems, and Sociology.
- First Sample: To study comprehension validity and exploratory factor analysis (EFA), an initial intentional sample of 50 participants from a digital literacy workshop was used, part of an inter-university project focused on active aging. Of these participants, 48% were women and 52% were men, aged between 55 and 78 years.
- Second Sample: For the confirmatory factor analysis (CFA), a second sample consisting of 178 individuals aged between 57 and 88 years was used (49% women and 51% men).

2.3 Instruments

The scale is a self-developed instrument based on the analysis of previous research on digital citizenship competence, specifically adapting the DigComp framework to the older adult population. Its development focused on two areas: Area 1, "Searching for and managing information and data," and Area 4, "Security." Specifically, it addressed competences 1.1 related to "Navigating, searching, and filtering data, information, and content" and 4.1 "Protecting devices."

DigComp classifies each competence into 8 skill levels, arranged from lowest to highest complexity. Each level includes an indicator that describes the specific capabilities associated with it. Based on this structure, a contextualization for the field of active aging (EA) was developed, focusing on the first four levels of difficulty.

The developed scale consists, first of all, of an introductory section that outlines the study's objective, ensures anonymity, and requests consent to participate. The items are presented as situations related to digital competencies, and the levels of proficiency are ordered on a Likert scale with 5 response options, ranging from 1 (I couldn't do it) to 5 (I can do it without help). The situations posed in each item are linked to a socially active life; thus, in the first competence, the items relate to searching for information about hotels, restaurants, and routes to cities. In the second competence, the items are related to protecting bank accounts, devices, and the information stored on them (Table 1).

2.4 Data analysis

The content validity ratio (CVR) was calculated, along with the frequency of items to identify missing values and detect outliers, as well as the Kolmogorov-Smirnov and Shapiro-Wilk normality tests. Internal consistency was evaluated using the Omega coefficient

TABLE 1 Probable situations included in the scale.

Item	What would you know what to do in these situations?
i1108	Needs to find a place to have a barbecue with a playground using a mobile app.
i1111	Attended an exhibition where there are replicas of works of art and wants to find more information about them online.
i1115	Needs to find a hotel by the beach through the internet.
i1118	Is traveling in Granada and wants to have dinner at a restaurant serving traditional local cuisine.
i1123	Wants to drive to Lisbon and needs to find the route to take using a mobile app, such as Google Maps.
i4102	Received a message from their bank notifying them of a charge on their card, and there is a phone number to call if they did not make that purchase.
i4106	Wants to protect a folder on their computer.
i4110	Wants to secure their smartphone in case of theft or loss.
i4111	Wants to protect their home Wi-Fi network.
i4113	Shares the computer with other family members and wants to protect their information.

Source: created by the authors.

TABLE 2 Content validity index.

Values obtained for each item					
Item	RVC	RVC′	Item	RVC	RVC′
i1108	0.45	0.73	i4102*	0.82	0.91
i1111	0.64	0.82	i4106*	0.82	0.91
i1115*	0.82	0.91	i4110	0.64	0.82
i1118*	0.82	0.91	i4111*	1.00	1.00
i1123*	1.00	1.00	i4113*	0.82	0.91

*Indicates RVC and RVC' values >0.7.
Source: created by the authors.

(McDonald, 1999), as the data did not follow a normal distribution. Data processing was carried out using the SPSS statistical package v.27 and its companion Analysis of Moment Structures (AMOS).

Additionally, an exploratory factor analysis (EFA) was conducted to determine construct validity, utilizing the Bartlett's Chi-square statistic and the Kaiser-Meyer-Olkin (KMO) coefficient. Subsequently, a confirmatory factor analysis (CFA) was performed to verify the psychometric characteristics of the proposed model. The indices calculated included Chi-square/df, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA), along with their confidence intervals (CI: 90%).

3 Results

3.1 Adaptation of the DigComp model to the scale of internet browsing and cybersecurity in older adults

The digital competencies adapted to the framework of active aging (EA) were 1.1 and 4.1. In DigComp, the competency levels are organized into four categories, ranging from lower to higher difficulty. Each level is described by an indicator that defines its specific capabilities. Based on this information, a contextualization for the EA domain was developed. For instance, the first level for the competency "information search" was described as: "Knowing how to search (with support) for available information on the internet about places, leisure venues, artworks, etc." The fourth and final level for this competency was described as: "Knowing how to select keywords for searches, calculate routes using applications, and use Really Simple Syndication (RSS) channels to stay informed, etc."

The situations presented in each item were linked to a socially active life. In competency 1.1, many items were related to travel, outings, and searching for leisure venues. For competency 4.1, the items focused on knowing how to react to banking fraud, protecting devices, and ensuring information privacy.

3.2 Adaptation of the DigComp model to practical tests of internet browsing and cybersecurity in older adults

Three practical tests were conducted. The first involved searching for information on the benefits of ginger (Task 1), the second was finding a secure website for an online purchase (Task 2), and the third was setting up the mobile phone using PIN access or a screen unlock (Task 3).

These three tasks are linked to the competencies described in the DigComp framework: for Area 1 (Task 1) and for Area 4 (Tasks 2 and 3). Completing Task 1 helps us to measure the ability to search for and select relevant information in digital environments, and completing Tasks 2 and 3 demonstrates people's ability to protect themselves and ensure the security of their digital devices.

3.3 Content-based validity

Once the expert panel provided their individual judgments, the content validity ratio (CVR and CVR') was obtained for each item (Table 2), following the models of Lawshe (1975) (CVR) and Tristán-López (2008) (CVR').

According to the results obtained (Table 2), 92% of the items ($n = 37$) scored above 0.58, which is the minimum required CVR'. Only 1 item (8%) did not meet the minimum requirement. This item was separated from the others for refinement, taking into account the qualitative responses provided in the expert judgment, and it underwent a subsequent review. The remaining items were integrated into the item bank of the pilot evaluation instrument, which was later used in an experimental setting with groups of older adults.

According to Tristán-López's (2008) model (CVR'), the validity index of the entire item bank (CVI) is set at the simple average of the CVR' values of each item. In our case, the obtained value was = 0.86, which we can consider optimal.

3.4 Exploratory factor analysis

To determine the suitability of the data before conducting the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure was used. The obtained result suggested good sampling adequacy and strong correlations between the variables, making it appropriate to extract significant factors. The same was true for the result of the Bartlett's test of sphericity (Kaiser = 0.870; $\chi^2 = 1306.437$, $p < 0.001$). As we can see, the levels obtained from both tests confirmed the feasibility of conducting an exploratory factor analysis (EFA) with the sample (Quiroz et al., 2021).

The extraction method used was principal components with Varimax rotation. Regarding the total explained variance, the factor analysis indicates that 69.16% of the variance can be explained by two components or factors, grouping the different items. Only items with a loading >0.5 were considered. The factor analysis conducted on the 26 items of the questionnaire revealed the existence of two main factors. The structure matrix shows the correlations between each item and the factors, indicating that items related to information-seeking (items 1 and 13) have high correlations with Factor 1, while items related to digital security (items 25 and 26) have high correlations with Factor 2. On the other hand, the pattern matrix reflects the weights of each item on the factors, confirming that information-seeking items load heavily on Factor 1 and digital security items on Factor 2. Some items, like item 16, show significant loadings on both factors, suggesting possible ambiguity in their classification and the need for further review. Factor 1 included 13 items (loadings between 0.966 and 0.570), and Factor 2 had 13 items (loadings between 0.357 and 0.990) (Table 3). This analysis provides a solid basis for understanding the competencies evaluated and suggests areas for improvement in the formulation of the questionnaire items. The result of this analysis leads to a questionnaire design with 26 items and two components (Table 3).

3.5 Criteria-based validity

In the practical tests, regarding the three tasks described in 3.2, four time ranges were established, corresponding to the equitable distribution of older adults based on the time taken to complete each test. All subjects completed the tests. To determine the criterion validity or external validity of the EAD-Cpsenior, correlations were analyzed between its items, the completion of the tests, and effectiveness in terms of execution time or latency (Tables 4, 5).

A positive correlation is observed between 9 out of 11 of the 13 items for competency 4.1 and performance on practical tests 2 and 3, respectively. The significant values range from that obtained for item 19 in task 2 ($r = 0.269$, <0.001) to that of item 18 in task 3 ($r = 0.544$, <0.001). Additionally, for items focused on competency 1.1, 7 out of 10 show significant correlations with tasks 1 and 2. The values range from that obtained for item 10 in task 1 ($r = 0.436$, <0.001) to that of item 12 in task 2 ($r = 0.473$, <0.001). For the remaining items, a correlation was observed, but it was not found to be significant, so they were excluded.

The comparison of the scale results with performance outcomes has allowed us to verify that it indeed measures the digital competencies of older adults related to competencies 1.1 and 4.1 of the Digcomp framework (van Deursen and van Dijk, 2009).

TABLE 3 Exploratory factor analysis (EFA).

Item (cod.)	Factors	
	1	2
Item 2 (i1108)	0.894	
Item 4 (i1111)	0.844	
Item 8 (i1115)	0.911	
Item 11 (i1118)	0.966	
Item 13 (i1123)	0.951	
Item 15 (i4102)	0.343	0.587
Item 19 (i4106)		0.677
Item 22 (i4110)		0.725
Item 23 (i4111)		0.891
Item 25 (i4113)		0.990

Extraction method "principal components analysis."
Source: created by the authors.

TABLE 4 External validity.

	Item 2	Item 4	Item 8	Item 11	Item 13
Practical1	0.348*	0.240	0.393**	0.394**	0.211
R. Tpo1	0.070	−0.006	0.099	0.092	0.037
Practical2	0.451**	0.324*	0.385**	0.379**	0.403**
R. Tpo2	0.357*	0.181	0.252	0.405**	0.245
Practical3	-	-	-	-	-
R. Tpo3	-	-	-	-	-

Correlations between items of Component 1. Practical tests and time range.
**Correlation is significant at the 0.01 level (two-tailed). *Correlation is significant at the 0.05 level (two-tailed).
Source: created by the authors.

TABLE 5 External validity.

	Item 15	Item 19	Item 22	Item 23	Item 25
Practical1	0.226	0.089	0.099	0.142	−0.084
R. Tpo1	0.214	−0.019	0.078	0.046	−0.023
Practical2	0.474**	0.269*	0.399**	0.222	0.148
R. Tpo2	0.324*	0.155	0.240*	0.201	0.074
Practical3	0.451**	0.303*	0.463**	0.264*	0.264*
R. Tpo3	0.194	0.143	0.176	0.105	0.035

Correlations between items of Component 2. Practical tests and time range.
**Correlation is significant at the 0.01 level (two-tailed). *Correlation is significant at the 0.05 level (two-tailed).
Source: created by the authors.

3.6 Confirmatory factor analysis

Based on the previous results, the final version of the scale was administered to 178 people, and this time it consisted of 10 items (5 for each competency). The selected items were the 10 that scored highest in the principal components factor analysis (Table 3) and in the correlation analysis with the practical tests (Tables 4, 5).

A structural equation modeling (SEM) study was conducted to test whether the set of observed variables represents a series of underlying latent constructs or factors (Figure 2). To calculate various model fit indices, the parameters recommended by Hair et al. (2013) were used for samples with $n \leq 250$ and m (number of variables) ≤ 1.

The model fit indices (Chi-square/df = 2.371, CFI = 0.967, TLI = 0.954, and RMSEA = 0.088 [0.063 −0.113]) suggest a satisfactory fit, allowing us to infer that the model aligns with the observed data.

Figure 2 shows the resulting path diagram of the CFA with two obtained components. It reveals a strong relationship between the two competencies (Factor 1 and Factor 2) (=0.79). Regarding the relationship of each item with each component (indicated by path coefficients or factor loadings), items from Factor 1 show a high factor loading (ranging from 0.88 for item 13 to 0.77 for item 8). Similarly, items from Factor 2 also exhibit fairly high loadings (ranging from 0.88 for item 19 to 0.57 for item 15). The similarity in content between items 8 and 11 may indicate the possibility that they share variance not explained by the latent factor, justifying the correlation between their errors (Hair et al., 2013).

3.7 Findings

Finally, the results obtained in this study confirm that this scale (based on the DigComp framework) is a valid and reliable tool for assessing digital competencies in internet navigation and cybersecurity among older adults. Additionally, it is important to mention that the positive correlation between

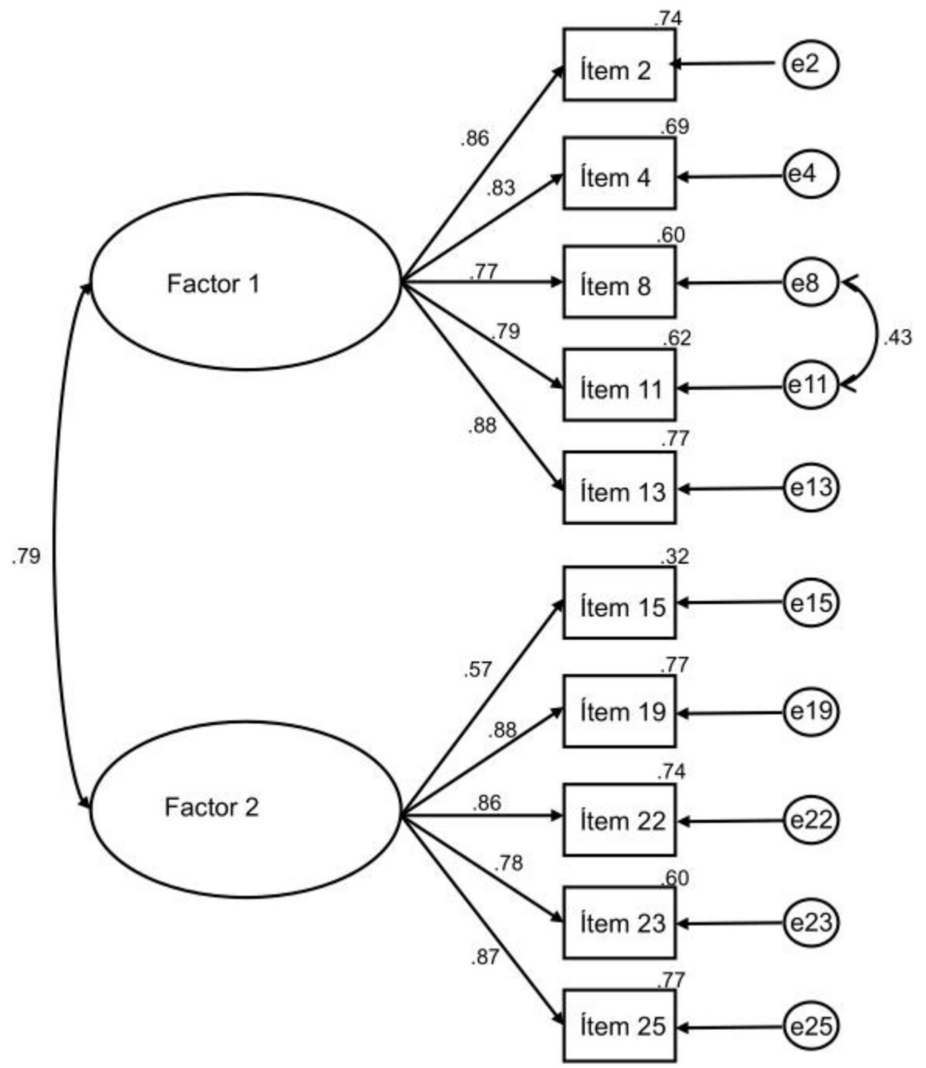

FIGURE 2
CFA model. Created by the authors.

the items of the scale and the practical tests conducted also confirms the validity of the developed instrument. These findings open a new avenue for exploring the DigComp framework within the older adult population, which could be implemented in other senior training programs to identify competency gaps, while also establishing proposals to assist in their digital literacy.

4 Discussion

Validating this scale will enable its use to evaluate these competencies in this population group and to design training plans suited to the knowledge level of the assessed population, supporting the creation of effective training programs and addressing the digital divide among older adults, as highlighted during the COVID-19 pandemic (Seifert et al., 2021).

The high content validity index (0.86) confirms that the scale effectively captures key aspects related to competencies in navigation and cybersecurity. This result aligns with other studies that also used the DigComp model as a basis for evaluating digital competencies across various population groups, highlighting the applicability of this model in contexts of learning and technological skill development (Mattar et al., 2022). The adaptation of competencies 1.1 (browsing, searching, and filtering data) and 4.1 (device protection) in this study allows the instrument to focus on critical areas affecting digital inclusion for older adults.

The Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) reflected the existence of two independent competencies, which is consistent with the theoretical structure of the competencies outlined in the DigComp framework. In particular, the grouping of items related to navigation and cybersecurity into two distinct and independent competencies supports the idea that these competencies, while related, represent different dimensions of digital knowledge and skills. This aligns with other studies that also emphasize the importance of addressing digital literacy and cybersecurity as independent yet interconnected components of digital competence (van Deursen and van Dijk, 2009).

It is essential to highlight that the positive relationship observed between the elements of the scale and the practical tests carried out also reinforces the validity of the instrument created. This finding suggests that the scale not only accurately measures the self-reported digital competencies of the participants but also has the ability to predict their actual performance in practical situations, which is essential for ensuring the applicability and usefulness of the scale in real-world contexts (van Deursen and van Dijk, 2009).

The fact that the proposed model showed a good fit in the CFA with the final sample indicates that the scale is a solid and structured instrument for measuring the digital competencies of older adults in the areas of navigation and cybersecurity. This validation is particularly significant considering the need to promote digital literacy among the older adult population, as previously noted by authors such as Karaoglu et al. (2021), who highlighted the benefits that the use of technology can bring to this demographic in terms of wellbeing and social participation.

However, aside from the validation of the scale, the results also reflected that older adults continue to show a certain degree of reluctance to use technology for financial transactions and other sensitive activities. This aligns with other studies that have identified a higher level of distrust toward the use of the internet and digital technologies in this sector of the population (Gupta and Chennamaneni, 2018; Huang and Bashir, 2018), highlighting the need to not only focus on acquiring digital competencies but also on building trust and the perception of security in the use of technologies.

5 Conclusions

The scale validated in this study provides a useful tool for assessing and improving digital competencies in older adults, in line with the DigComp framework. By offering a reliable and specific measurement of internet navigation and cybersecurity skills, this scale can be utilized by educational institutions, civil society organizations, and governments to design digital literacy programs that address the real needs of older adults, thereby contributing to reducing the digital divide and promoting active and safe aging in the digital era.

Among the limitations of this study, we highlight that the sample included a wide age range and its selection was intentional, being limited to participants in a digital literacy workshop. In this regard, it would be advisable to conduct the study in a population with a different level of interest in digital literacy.

For the validation of the scale, a national sample was used, and for its continuation, the international community is invited to apply this scale in their respective contexts in order to measure the digital competence of older adults with the aim of improving their digital literacy programs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The participants provided written informed consent to participate in this study.

Author contributions

FR-M: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. RI-S: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. YC-G:

Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JI–M: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

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