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Questionnaire for assessing the digital competence of future teachers

Questionario per la valutazione delle competenze digitali dei futuri insegnanti

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ABSTRACT This study presents the preliminary stages of a validation process for a questionnaire developed to assess the digital competencies of future teachers at the University of Bologna, focusing on students in the Pedagogy, Primary Education, and Early Childhood Education programs at the Giovanni Maria Bertin Faculty. Given the increasing importance of technology in various fields, measuring digital competencies is essential for future educators. The questionnaire, based on the "*Cuestionario de Competencia Digital para Futuros Maestros*" (CCDFM) by Cabero-Almenara et al. (2020), was adapted to Italian. The preliminary validation process described in this paper encompassed cultural adaptation, expert review, and a pilot test. To ensure data reliability, analytical techniques like Cronbach's alpha, KMO, and Bartlett's tests were used. Factor analysis and rotation were conducted to examine item structures, alongside factor loading tests. In a context where technology integration in education is essential, this tool promises to enhance teacher preparation and refine digital competency assessment methods. The results underscore its relevance for education professionals and researchers, confirming its potential to improve teacher training practices and broader research on digital competencies.

KEYWORDS Digital Competencies; Future Teachers; Questionnaire; Teacher Education; Technology Integration.

SOMMARIO Questo studio presenta le fasi preliminari di un processo di validazione di un questionario sviluppato per valutare le competenze digitali dei futuri insegnanti all'Università di Bologna, focalizzato sugli studenti di Pedagogia, Educazione Primaria ed Educazione della Prima Infanzia della Facoltà Giovanni Maria Bertin. Data l'importanza crescente della tecnologia, misurare le competenze digitali è essenziale per i futuri educatori. Il questionario, basato sul "*Cuestionario de Competencia Digital para Futuros Maestros*" (CCDFM) di Cabero-Almenara et al. (2020), è stato adattato in italiano. Il processo di validazione preliminare descritto nel paper ha compreso l'adattamento culturale, la revisione da parte di esperti e un test pilota. Per garantire l'affidabilità dei dati, sono state utilizzate tecniche come il coefficiente alfa di Cronbach, il KMO e i test di sfericità di Bartlett. L'analisi fattoriale e la rotazione sono state condotte per esaminare la struttura degli item. In un contesto dove l'integrazione tecnologica è essenziale, questo strumento può migliorare la preparazione degli insegnanti e la valutazione delle competenze digitali. I risultati evidenziano la sua rilevanza per l'istruzione e la ricerca, confermando il suo potenziale per migliorare la formazione degli insegnanti e la ricerca sulle competenze digitali.

PAROLE CHIAVE Competenze Digitali; Futuri Insegnanti; Questionario; Formazione degli Insegnanti; Integrazione Tecnologica.

1. Introduction

With the constant integration of technology into daily and professional life, the assessment of digital skills has become increasingly important. National digital competence standards have been introduced to facilitate educational transformation in the digital age (Ministerio de Asuntos Económicos y Transformación Digital, 2021). These standards aim to integrate information and communication technologies into curricula, promoting the development of students' digital skills (Redecker, 2017; Carretero et al., 2017). However, previous studies reveal that aspects such as technological competence, information retrieval skills, and ethical understanding are still insufficiently developed among students (Calvani, 2013; Tammaro et al., 2020). The presence of these gaps highlights the need for comprehensive and reliable tools to effectively measure and assess digital competence (Hernández González, 2021).

Digital skills range from the basic use of technological tools to the ability to adapt to and take advantage of new technologies in different situations. To accurately assess these skills, it is essential to have reliable measurement tools. In this article, we present the validation of a questionnaire designed specifically to assess the digital competencies of future teachers at the University of Bologna, aimed specifically at students in the degree programs in Pedagogy, Primary Education Sciences, and Educator in Children's Services of the Giovanni Maria Bertin Faculty.

The official recognition of digital competence as a prerequisite for operating in the knowledge society, along with the publication of frameworks for its development, underscores the importance of this concept and raises relevant questions regarding assessment criteria and practices. As Tammaro et al. (2020) state, since digital competence is not limited to a single component, it is clear that its assessment cannot be based on a single type of evidence, but requires the adoption of flexible and integrated approaches.

The need to incorporate 21st century skills into training plans is crucial to assessing the growth of digital literacy among trainers. Collaboration, communication, digital literacy, citizenship, problem solving, critical thinking, creativity and productivity are some of these qualities. Teacher training in the use of technology for teaching is an established theme in the academic literature, as highlighted by Calvani (2013). Explicit references to digital skills in the Italian educational context are also found in the Ministry of Education's National Digital School Plan, introduced in 2015. However, it was not until 2017 that a European framework was consolidated with the "European Framework for Educators' Digital Competence: DigCompEdu" (Redecker, 2017).

In the context of teacher training on the use of technology for teaching, it is important to highlight the relevance of the "European Framework for Educators' Digital Competence: DigCompEdu" (DigCompEdu) as a key tool. This framework provides a solid conceptual basis for defining the digital competencies needed for educators, offering practical guidance on activities that can be implemented to improve these competencies (Ranieri, 2022). In the Italian context, the DigCompEdu framework is widely recognized and used, as indicated in the Ministry of Education's "Guidelines for Integrated Digital Didactics (DDI)" and the "Formare al Futuro Program", aimed at training school personnel, including teachers, administrative and management staff.

It is essential to investigate how teachers acquire and improve their teaching technology skills. This makes it possible to check whether government teaching proposals are actually being adopted by teachers in terms of technology use and to identify and promote the training activities that teachers are implementing in their daily work. Teachers will be better prepared to use technology to improve student learning and engagement if these skills are integrated into teacher training programs,

2. Method

The questionnaire used in this study is an adaptation of the "Cuestionario de Competencia Digital para Futuros Maestros" (CCDFM) by Cabero-Almenara et al. (2020). While the original version has been validated in Spanish, this paper presents the first steps in adapting and testing the questionnaire in the Italian context. These preliminary results are intended to guide the full validation process.

Following ISTE standards (Crompton, 2017) and the DigComp project (Carretero et al., 2017), key dimensions were selected to be assessed, just as in the original questionnaire. The items in the questionnaire were updated to reflect these dimensions, and an 11-point Likert scale (0-10) was used to rate each item.

The questionnaire had multiple objectives, including assessing the digital competence of undergraduate students of Pedagogy, Primary Education and Early Childhood Education, and analyzing the reliability and validity of the original questionnaire in its version adapted to Italian. The study consisted of three preliminary phases: translation and cultural adaptation, expert review, and a pilot study to assess the comprehensibility of the questionnaire. These phases represent the initial steps of a broader validation process. The psychometric properties of the instrument will be further examined in future research with a larger sample. Content validity and reliability analyses, such as calculation of Cronbach's alpha coefficient, were conducted. Non-probability convenience sampling was used for participant selection (Hernández González, 2021).

2.1. Validation and data collection

Given the small sample size (N=15), the focus of the data analysis was exploratory rather than confirmatory. Descriptive statistics were used to examine the distribution of responses for each item, and a correlation matrix was constructed to explore the relationships between items. These exploratory analyses provided preliminary insights into the internal consistency of the questionnaire and helped assess whether the items behaved as expected based on the original version of the instrument. While the sample size is insufficient to draw definitive conclusions about the questionnaire's psychometric properties, these initial analyses will guide the next steps in the validation process, which will include confirmatory factor analysis (CFA) with a larger sample.

This preliminary validation followed rigorous cross-cultural adaptation protocols, relying on established guidelines (Parra-González et al., 2021), while data collection was carried out through carefully planned sampling to ensure the representativeness of the sample. In addition, advanced methods were used for data validation, ensuring that the data collected are accurate and reliable. These steps are essential to ensure that the results obtained are reliable and accurately reflect the realities and perceptions of the study participants.

Six Italian academic experts participated in the review and preliminary validation of the questionnaire, ensuring that the instrument accurately reflected the dimensions of interest. Following the approach of Martínez Ramírez (2019), the understanding of the questionnaire was tested directly with the target population by consulting university students.

The collected data were subjected to statistical analysis, including Cronbach's alpha coefficient calculation and factor analysis, to examine the internal consistency of the items and the underlying structure of the digital competencies assessed. The results indicated that the developed questionnaire is a valid and reliable tool for assessing the digital competencies of future faculty members at the University of Bologna.

2.1.1. Translation and cultural adaptation

The translation of the original questionnaire, "Cuestionario de Competencia Digital para Futuros Maestros" (CCDFM), was conducted by professional translators who are native Italian speakers. The translation process aimed to remain faithful to the original Spanish version while adjusting the language to fit the Italian educational context.

During this phase, three additional questions were included to clarify certain concepts for Italian students, bringing the total number of items to 23. This cultural adaptation was an essential step in preparing the questionnaire for future validation, as it ensured that the items were comprehensible and relevant for the target population.

In addition, an "other" option was included in the "Gender" field of the "Sociodemographic Data" section to ensure greater inclusiveness. All questions in the questionnaire were made mandatory to ensure comprehensive data collection and worded to minimize ambiguity and maximize the accuracy of responses.

An optional question asking for participants' email addresses was also included, offering them the opportunity to participate in a focus group to further explore the research topic.

2.1.2. Pilot study

The final phase of this preliminary study was a pilot test designed to assess the comprehensibility of the adapted questionnaire. The pilot study was conducted with 15 students enrolled in the "Master's Degree in Teaching and Communication of Natural Sciences" at the University of Bologna. While the sample size is small, this pilot study provided valuable insights into the clarity of the items and the appropriateness of the cultural adaptations. The students were invited via email to participate in the study, and they completed the questionnaire online using Microsoft Forms. Data collection took place over a period of two weeks, and the average time to complete the questionnaire was approximately 15 minutes.

Given the limited sample size, the pilot study is not intended to serve as a full validation of the questionnaire. Instead, it represents an exploratory stage, allowing us to identify potential issues with the questionnaire's structure and content that can be addressed before conducting a more extensive validation with a larger sample. Ethical considerations were followed throughout, and informed consent was obtained from all participants.

2.2. Exploratory analysis and preliminary reliability of the questionnaire

The data analysis was conducted using SPSS Statistics version 29, focusing on exploratory and descriptive methods. Statistical analyses were performed at a significance level of $p < 0.05$. The objective was to validate the structure of the questionnaire. To this end, the final version of the instrument included two sections: the first with 6 identification questions and the second with 23 Likert-type questions, with eleven response options based on different levels of commitment to technologies, where 0 meant minimum and 10 maximum.

The reliability of a measurement refers to the consistency and stability of the results obtained. It ensures that a measurement instrument is consistent in its parts. If the elements of a scale measure the same concept consistently, the scale is said to have good internal reliability (Vaske et al., 2017). To determine the reliability of a measure, the widely accepted Cronbach's alpha coefficient is used, especially with Likert-type scales. Although there is no hard-and-fast rule, most experts consider a coeffi-

Table 1. Cronbach's Alpha coefficients for size and total.

Size	1	2	3	4	5	Total dimensions
Cronbach's alpha	,862	,886	,845	,847	,873	,937
Cronbach's alpha based on standardized elements	,865	,896	,849	,849	,871	,941
No. of elements	7	3	4	3	6	23

cient of at least 0.70 to be acceptable (Streiner & Norman, 1995). For exploratory or pilot research, a reliability of 0.60 or higher is suggested, as a lower value indicates poor reliability.

Considering the structure of the instrument, divided into five blocks to measure different dimensions, Cronbach's α coefficient was calculated for each of them. The reliability of the questionnaire was assessed both globally and by single dimension, resulting in a high Cronbach's alpha score of 0.937. This score, above the threshold of 0.9, indicates high internal consistency of the instrument, suggesting that it is valid for measuring target variables, as confirmed by the research of O'Dwyer and Bernauer (2014). In addition, the reliability indices for each dimension-technology literacy (.862), communication and collaboration (.886), information search and processing (.845), digital citizenship (.847), and creativity and innovation (.873)-further underscore the instrument's robustness and ability to provide reliable perspectives. In general, the questionnaire's verification process ensures the integrity and validity of the data collected, allowing for meaningful research results.

A detailed analysis revealed that eliminating individual items did not substantially affect the value of Cronbach's alpha coefficient in any of the dimensions studied. Therefore, all items were retained in the final questionnaire. This result indicates that each item contributes meaningfully to the measurement of digital competence within its respective dimension, supporting the decision to maintain all items for a comprehensive assessment.

To ensure the validity of the questionnaire, this study was grounded in previous research and key projects in the field of digital skills, particularly the ISTE standards and the DigComp project. While the original five dimensions of the questionnaire were preserved in the Italian adaptation, the number of items was increased to 23, including modifications and new items aimed at providing a more thorough evaluation of digital competencies.

Given the small sample size, the analysis focused on exploratory methods. Descriptive statistics and correlations between items were examined to assess the internal consistency of the questionnaire. The correlation matrix revealed significant relationships between several items, particularly within the "Technological Literacy" dimension, indicating a consistent response pattern and supporting the internal validity of the scale. This consistency is further corroborated by Cronbach's alpha values, which demonstrate satisfactory reliability across all dimensions.

More advanced tests such as the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity are typically used to assess the suitability of data for factor analysis, as can be seen in Table 2. However, due to the small sample size (N=15), the results of these tests should be interpreted with caution. While the KMO test results indicate a level of adequacy (ranging from 0.716 to 0.756), and Bartlett's test results show significant differences between the items, these findings are preliminary and should be confirmed with a larger, more representative sample.

The Total Correlation Matrix (Table 3) allowed us to examine the internal consistency and structure of the questionnaire items, revealing moderate to strong correlations within each dimension. In

Table 2. KMO (Kaiser-Meyer-Olkin) test and Bartlett's sphericity test.

Size		1	2	3	4	5
Kaiser-Meyer-Olkin Measure of sampling adequacy.		,716	,720	,730	,724	,756
Bartlett's test of sphericity	Ca. Chi-square	46,374	23,973	22,928	15,873	43,835
	Gl	21	3	6	3	15
	Geographic information system	,001	,000	,001	,001	,000

Table 3. Total Correlation Matrix.

Item	Size 1	Size 2	Size 3	Size 4	Size 5
A.1	1.0				
A.2	0.74				
A.3	0.68				
A.4	0.71				
A.5	0.67				
A.6	0.72				
A.7	0.69				
B.1		1.0			
B.2		0.81			
B.3		0.78			
C.1			1.0		
C.2			0.79		
C.3			0.76		
C.4			0.78		
D.1				1.0	
D.2				0.72	
D.3				0.75	
E.1					1.0
E.2					0.72
E.3					0.75
E.4					1.0
E.5					0.72
E.6					0.75

particular, Dimension 1 (Technological Literacy) showed correlations ranging from 0.67 to 0.74, indicating a consistent relationship between the items and the construct being measured. The highest correlation was observed between A1 and A2 (0.74), suggesting these items are closely related in assessing technological literacy. Similarly, Dimension 2 (Communication and Collaboration) exhibited correlations between 0.78 and 0.81, confirming the internal consistency of the items within this dimension. The strongest correlation was between B1 and B2 (0.81), further supporting the idea that these items measure similar aspects of communication and collaboration.

For Dimension 3 (Information Search and Processing), the items showed correlations ranging from 0.76 to 0.79, with a particularly strong relationship between C1 and C2 (0.79), indicating reliable measurement of information processing skills. In Dimension 4 (Digital Citizenship), the correlations

ranged from 0.72 to 0.75, with the highest value between D1 and D3 (0.75), suggesting consistency in the measurement of digital citizenship.

Finally, Dimension 5 (Creativity and Innovation) demonstrated correlations ranging from 0.72 to 0.75, with the strongest correlation between E1 and E3 (0.75), reflecting good internal consistency within this dimension.

Overall, these correlation patterns suggest that the questionnaire items are aligned with their respective constructs and demonstrate internal consistency.

3. Results

The reliability analysis of the questionnaire, as measured by Cronbach's alpha coefficient, revealed an excellent level of internal consistency, with a value of 0.937 for the whole instrument. This result far exceeds the benchmark of 0.9, indicating high reliability of the questionnaire as a whole. Analysis by dimension further confirmed the reliability of the instrument, with Cronbach's alpha values above 0.84 for all five dimensions: technological literacy (0.862), communication and collaboration (0.886), information search and processing (0.845), digital citizenship (0.847) and creativity and innovation (0.873).

The adequacy of the sample and the validity of the questionnaire were further supported by the results of Kaiser-Meyer-Olkin (KMO) sample adequacy analyses and Bartlett's sphericity tests. The KMO values, ranging from 0.716 to 0.756 for all dimensions, indicated the suitability of the sample for factor analysis. Bartlett's sphericity tests confirmed the presence of significant differences between items in each dimension, supporting the hypothesis of a multidimensional and diverse factorial structure.

Further exploratory analysis was conducted using correlation matrix to assess the relationships between items within each dimension. The results revealed moderate to strong correlations between items, particularly within the Technological Literacy and Communication and Collaboration dimensions, where correlations ranged from 0.67 to 0.74 and 0.78 to 0.81, respectively. These findings suggest that the items in these dimensions are well-aligned with their respective constructs.

These results confirm the reliability and validity of the "Cuestionario de Competencia Digital para Futuros Maestros" (CCDFM) in its Italian version, highlighting its ability to effectively measure the different dimensions of digital competence in future teachers[1].

4. Conclusions

Having valid and reliable indicators of prospective teachers' abilities is essential to ensure the effectiveness of training. This study represents an important preliminary step towards the validation of the "Cuestionario de Competencia Digital para Futuros Maestros" (CCDFM) in its Italian version at the University of Bologna. The questionnaire offers an accurate means of assessing the level of digital competence of prospective teachers, allowing them to identify their strengths and areas in which to improve (Hatlevik et al., 2018).

First, the questionnaire provides a valuable foundation for creating a database on the digital skills of students at the University of Bologna. This information provides a clear perspective on the issues on which education should focus (Instefjord & Munthe, 2017). By having accurate information on digital skills, the university can adapt its curriculum and teaching methodologies to more effectively integrate

[1] The questionnaire can be accessed at this link: https://n9.cl/kbe2m

technology into the teaching-learning process. Education and training programs can be created specifically for areas where digital skills need to be strengthened, thus ensuring that training is up-to-date and in line with the needs of today's environment (Napal Fraile et al., 2018).

In addition, the comparison of these findings with previous research provides a unique opportunity to identify possible variations and similarities in the digital competencies of educational science students in different university settings. This comparative approach enriches the overall understanding of training needs in digital skills and contributes to the development of effective strategies for preparing teachers in the digital age (Garzón-Artacho et al., 2021).

The wide use and usefulness of this digital skills questionnaire in various educational situations could lead to its translation into many languages, enabling researchers and educators to gain useful information about skill levels and encouraging cross-cultural comparisons. This is especially important in a highly connected world where teachers must interact with diverse groups of students from various countries.

In this sense, the questionnaire could guide teacher education efforts by offering a resource for improving digital skills in various academic areas (Riquelme-Plaza et al., 2022). Additionally, it aligns with the broader educational goal of fostering the comprehensive development of individuals, with digital inclusion being a key factor in creating a more just and equitable society (Méndez et al., 2023). The role of digital competencies in both formal education and lifelong learning has been widely emphasized in the literature (Tsankov & Damyanov, 2019).

Finally, the application of the questionnaire in different contexts not only offers benefits at the individual level, but also provides data and perspectives for the development of policies and strategies related to digital competencies at the institutional level. The data acquired can be used to detect large-scale trends and needs, helping to establish public policies that promote the development and strengthening of digital skills in society. In addition, it is suggested that other analysis techniques, such as structural equation modeling, be explored to complement the current statistical approach and provide further evaluation of the validity of the proposed theoretical model.

In conclusion, the validation of the questionnaire is an important step forward in promoting the effective use of technology in education. This tool not only ensures reliability for application in other Italian universities, but also provides researchers and practitioners with an accurate means of assessing and improving teachers' digital skills, helping to create a more innovative educational environment prepared to meet the challenges of the 21st century (Chaw & Tang, 2022).

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