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DEVELOPMENT AND VALIDATION OF A SCALE FOR MEASURING TEACHERS'[1] DIGITAL CITIZENSHIP LITERACY.

SVILUPPO E VALIDAZIONE DI UNO STRUMENTO DI MISURAZIONE[1] DELLE COMPETENZE PER LA CITTADINANZA DIGITALE DEI DOCENTI

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Abstract

The evolution that has taken place in the last thirty years concerning technology has led to important changes in everyday life (Piceci, 2020). These changes moved the attention to the concept of digital technologies, in particular the tools daily used. The European Union has implemented various interventions to promote the dissemination of digital culture through the European Digital Agenda with its emanations in the individual states of the Union, focusing on the availability of IT resources both from an infrastructural and information points of view. Concerning the concept of digital skills, EU created a first document in 2013 (Ferrari, 2013) then updated in 2017 with digiCom 2.1 (Carretero, Vuorikari & Punie, 2017) with the purpose of making a clear enumeration and definition. This study, starting from DigiComp 2.1, presents the process of creation and validation of the Italian Questionnaire on Digital Citizenship Skills for Teachers (Questionario sulle Competenze della Cittadinanza Digitale - QCCD). The sample used is made up of 351 teachers or student training to become teachers. Confirmatory Factor Analysis was performed to study the replicability of the factor structure obtained by EFA and it showed satisfactory goodness of fit indices for the hypothesized one-factor structure. Chi square (= 388.8, df = 189, $p < .001$) value and very positive goodness of fit indices (CFI = .988, TLI = .0987 SRMR = 0.069, RMSEA = 0.055). Results of content and construct validity were also adequate and complemented a very strong internal consistence of the measurement tool.

L'evoluzione tecnologica che si è avuta negli ultimi trent'anni ha portato a cambiamenti importanti nella vita di tutti i giorni (Piceci, 2020). Tali cambiamenti hanno contribuito ad accendere l'attenzione sul tema della tecnologia digitale, in particolare sugli strumenti da utilizzare quotidianamente. L'Unione Europea ha attuato diversi interventi per favorire la diffusione della cultura digitale attraverso l'organismo dell'Agenda Digitale Europea e delle sue emanazioni nei singoli stati dell'Unione, lavorando sulla diffusione e sulla disponibilità di risorse informatiche sia

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dal punto di vista infrastrutturale che informativo. In merito al concetto di competenze digitali, essa ha creato una catalogazione, introducendo un primo documento nel 2013 (Ferrari, 2013) aggiornato poi nel 2017 con il DigiCom 2.1 (Carretero, Vuorikari, & Punie, 2017).
Il presente studio, partendo dal DigiComp 2.1, presenta il processo di creazione e validazione di uno strumento di misurazione, il Questionario sulle Competenze di Cittadinanza Digitale per insegnanti (QCCD). Il campione per la validazione è composto da 351 insegnanti che hanno partecipato a Master del mondo Scuola Unicusano. L'analisi fattoriale di conferma è stata eseguita per studiare la replicabilità della struttura fattoriale ottenuta dall'EFA e ha mostrato una buona congruenza degli indici di adattamento per la struttura a un fattore ipotizzata. Valore del chi quadrato (χ^2 = 388,8, df = 189, p < .001) e gli indici di adattamento sono molto positivi (CFI = .988, TLI = .0987 SRMR = 0,069, RMSEA = 0,055). Anche i risultati della validità del contenuto e del costrutto sono adeguati e integrano una forte consistenza interna dello strumento di misurazione.
I test della NEPSY-II e l'AEPS utilizzati per la valutazione sono stati somministrati prima dell'inizio dell'attività e alla fine della sessione di incontri.

Keywords
Digital Skills, Digital Citizenship, DigiComp 2.1, Digital Skills Questionnaire, Teachers
Competenze Digitali, Cittadinanza Digitale, DigiComp 2.1, Questionario sulle competenze Digitali, Insegnati

Introduction

From the 1970s to nowadays, the evolution of technology in the IT field has seen several important stages, starting with the introduction of the large mainframes, moving on to personal computers and the establishment of Internet, and arriving to the great smartphone revolution in the 2000s. (Piceci 2020). It's worthy to remember that on October 29, 1969, the first transmission, through the network, of a package between the University of Los Angeles and the Stanford Research Institute took place and today in 2021 a large part of the mobile phones has integrated Artificial Intelligence modules (for example for the recognition of biometric data). In about thirty years we moved from technology with electrical infrastructure to electronic and digital one.

The events of 2020, the COVID-19 pandemic and the lockdowns, urgently required the need of reflection about various topics, including the growing importance and indispensability of digital in people's daily lives and its intrinsic characteristic of being an engine of inclusiveness at all levels. Previously, the emphasis was mostly focused on the compensatory support that digital could provide. The provision of distance learning in such an all-encompassing and sudden way led to a growing pressure on teachers and their stress (Piceci, Sgorlon, Peluso, 2020) but also to the strategies implemented to cope with it (Mariani, Piceci, Melchiori, 2020). These events highlighted new aspects and brought to the fore the close relationship existing between the technological and the psico-pedagogical aspects (Piceci, Cancellara, 2020). The institutions, in order to face and manage the sudden change, produced tools and methods to manage the process rather than suffer the consequences. On one side, the issue of the Digital Divide was addressed as far as possible, on the other one, they worked on the definition of Digital Skills (CD) necessary for a healthy and effective use of digital. The European Parliament in 2006, in the document on the new European Qualifications Framework (EQF) for lifelong learning, proposed a system, structured in 8 levels, to make the qualifications obtained by different European citizens comparable, translatable and transferable (Papetti, 2008). The document defined the key skills for development, where, for the first time, digital skills were included together with, for example, communicating in the mother tongue and communicating in foreign languages (European Official Gazette 2006). Later in 2013, the DigiComp 1.0 was published, a document that outlined the CDs (Ferrari, 2013) and in 2017 the DigiCom 2.1 (Carretero, Vuorikari, & Punie, 2017).

"The DigComp 1.0 framework had three levels of mastery in Dimension 3 (basic, intermediate and advanced). In DigComp 2.1 the levels have been increased to eight. A wider and more detailed range of levels of relevance supports the development of learning and training materi-

als." (Agency for Digital Italy 2017). In the context of digital transformation, the research team considered it important to develop a tool for measuring digital skills, especially among teachers, to identify any existing gaps to be fill up with psycho-educational programs. The issue of digital competence has become predominant in educational debate, both for a greater awareness about the use of new technologies in schools and for the socio-cultural process that involves cognitive aspects and the processing of basic information and knowledge (Calvini et al., 2009). It is evident that the introduction and use of digital technologies in schools and learning are characterized by little significance on a cognitive and cultural level. The role of teachers becomes crucial in the transformational process and it is mandatory to develop psycho-educational programs for them even before pupils. In the educational field, some evaluation questionnaires of Digital Skills have been developed, but, in most cases, they show a main criticality that is the lack of important dimensions for a complex process such as the training (Petrucco, 2019). Therefore, the need to have a tool that can keep up with the development of the use of technology arises. This article presents the development and validation process of a tool called Questionnaire on Digital Citizenship Skills (QCCD).

1. DigiComp 2.1 (Carretero, Vuorikari, Punie, 2017)

DigiComp 2.1 arises from the need to provide a framework on digital skills with a shared list to European citizens. The document follows the aforementioned DigiComp 1.0 updated in 2016 to version 2.0, where the terminology and the conceptual model have been modified, making them updated to the year of publication.

DigiComp 2.1 is a document defined as a "Science for Policy report" prepared by the scientific and knowledge service of the European Commission (JRC). It focuses on increasing the levels of mastery of the competences from three to eight.

The DigiComp framework is divided into 5 dimensions:

1. Dimension 1: Areas of skills identified as forming part of digital skills;
2. Dimension 2: Descriptors of competences and qualifications relevant to each area;
3. Dimension 3: Levels of proficiency for each competence;
4. Dimension 4: Knowledge, skills and attitudes applicable to each competence;
5. Dimension 5: Examples of use on the applicability of the competence for different purposes.

Compared to the first version, dimensions 1 and 2 have been added and dimension 3 is better articulated. The variations and evolutions are shown in the following table (Table 1).

Levels in DigComp 1.0	Levels in DigComp 2.1	Complexity of tasks	Autonomy	Cognitive domain
Foundation	1	Simple tasks	With guidance	Remembering
	2	Simple tasks	Autonomy and with guidance where needed	Remembering
Intermediate	3	Well-defined and routine tasks, and straightforward problems	On my own	Understanding
	4	Tasks, and well-defined and non-routine problems	Independent and according to my needs	Understanding
Advanced	5	Different tasks and problems	Guiding others	Applying
	6	Most appropriate tasks	Able to adapt to others in a complex context	Evaluating
Highly specialised	7	Resolve complex problems with limited solutions	Integrate to contribute to the professional practice and to guide others	Creating
	8	Resolve complex problems with many interacting factors	Propose new ideas and processes to the field	Creating

Table 1 – Evolution of DigiComp 1.0 to DigiComp 2.1 with major keywords of mastery levels (Ibidem)

8 levels of mastery are defined, synthetically represented in the metaphor of the approach to water to “learn to swim in the digital ocean” (Ibidem).

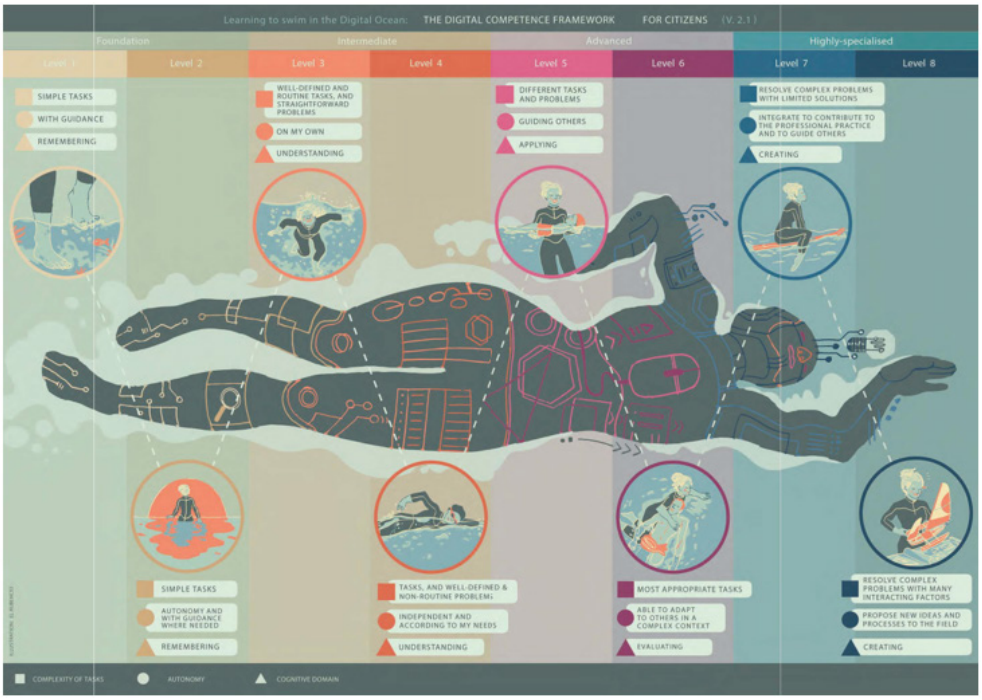

Figure 1 – The DigiComp metaphor 2.1 (Ibidem)

The different levels of competence that define learning outcomes are structured according to the taxonomy of Bloom (Engelhart, Furst, Hill, and Krathwohl, 1956), taking into account the structure and nomenclature of the European Qualification Framework. and using action verbs. This wider range of levels has been created to allow a better development of training programs and learning materials, as well as tools for assessing citizens' competences.

The assessing tool (QCCD) created and validated by the research team and here showed is based on the structure suggested by DigiComp 2.1.

2. The skills of Digital Citizenship.

By "Digital Citizenship" we mean the ability of an individual to have a conscious and responsible use of virtual means of communication, through an effective, creative and conscious use of technological tools. The critical and integrative approach to daily life should be included in this definition (Ministerial Decree no. 35 of 22 June 2020).

According to Choi (2016), the concept can be divided into four fundamental elements:

- Ethics, identifies behaviours related to safety, ethics, responsibility and awareness in communication in virtual communities (Afshar, 2013; Winn, 2012; Ribble, 2004; Ohler, 2012; Hollandsworth, Dowdy, Donovan, 2011);
- Media and Information Literacy - MIL, concerns the ease of access and use of digital tools but also critical thinking and the ability to manage information (Moeller et al., 2011; Mossberger, 2009; Marcinek, 2013; Ohler, 2012; Simsek & Simsek, 2013);
- Participation / Engagement (P / E), refers to involvement in political, economic and social life (Raoof, Zaman, Ahmad, Al-Qaraghuli, 2013; Bennett & Fessenden, 2006; Crowe, 2006) and in issues of civil interest (Kahne, Lee, Feezell, 2013; Lenhart et al., 2011; Tatarchevskiy; 2011).
- Critical Resistance (CR), in terms of political activism and criticism of public structures (Glassman, 2013; Herrera, 2012; DeLuca, Lawson, Sun, 2012; Mansour, 2012).
- In particular, in the field of teaching, DigCompEdu (2017) identified six basic skills

useful to be a fully Digital Citizen and to be able to teach Digital Citizenship to students:

- Professional engagement: use of digital technologies to communicate and collaborate with colleagues and for teacher's own personal development;
- Digital resources: identify, create and share digital resources;
- Teaching and learning: manage the use of digital technologies for teaching and learning;
- Assessment: reinforce assessments thanks to digital technologies;
- Empowering learners: use digital technologies for inclusion and active involvement of students;
- Facilitating learners' digital competence: facilitate creative and responsible use of digital technologies by students for sharing, communication, content creation and problem solving activities.
- According to this framework, the Questionnaire on Digital Citizenship Skills has been developed.

The following paragraphs cover the creation and validation process.

3. Digital Citizenship Skills Questionnaire

The Questionnaire on Digital Citizenship Skills aims to measure the level of skills relating to the use of digital tools in an autonomous, creative and functional way, particularly in teachers. The tool is in line with what indicated in DigComp 2.1 concerning the areas of expertise.

The 5 areas and 21 specific competences are as follows:

1. Literacy on information and data:
   - browse, search and filter data, information and digital content
   - evaluate data, information and digital content
   - manage data, information and digital content
2. Communication and collaboration:
   - interact with others through digital technologies
   - share information through digital technologies
   - exercise citizenship through digital technologies
   - collaborate through digital technologies
   - netiquette
   - manage digital identity
3. Creation of digital content:
   - develop digital content
   - integrate and rework digital content
   - copyright and license
   - programming
4. Security:
   - protect devices
   - protect personal data and privacy
   - protect health and well-being
   - environmental protection
5. Troubleshoot:
   - solve technical problems
   - identify needs and technological responses
   - use digital technologies creatively
   - identify digital skills gaps.

Each competence is explained through a declaration taken from DigiComp 2.1, as per Table 2:

Competence areas	Competences	Declaratory
Information and data literacy	Browsing, searching and filtering data, information and digital content	*To articulate information needs, to search for data, information and content in digital environments, to access and navigate between them. To create and update personal search strategies*
	Evaluating data, information and digital content	*To analyse, compare and critically evaluate the credibility and reliability of sources of data, information and digital content. To analyse, interpret and critically evaluate the data, information and digital content.*
	Managing data, information and digital content	*To organise, store and retrieve data, information, and content in digital environments. To organise and process them in a structured environment.*
Communication and collaboration	Interacting through digital technologies	*To interact through a variety of digital technologies and to understand appropriate digital communication means for a given context.*
	Sharing through digital technologies	*To share data, information and digital content with others through appropriate digital technologies. To act as an intermediary, to know about referencing and attribution practices*
	Engaging in citi- zenship through digital technologies	*To participate in society through the use of public and private digital services. To seek opportunities for self-empowerment and for participatory citizenship through appropriate digital technologies.*
	Collaborating through digital technol-ogies	*To use digital tools and technologies for collaborative processes, and for co-construction and co-creation of data, resources and knowledge.*
	Netiquette	*To be aware of behavioural norms and know-how while using digital technologies and interacting in digital environments. To adapt communication strategies to the specific audience and to be aware of cultural and generational diversity in digital environments.*
	Managing digital identity	*To create, and manage one or multiple digital identities, to be able to protect one's own reputation, to deal with the data that one produces through several digital tools, environments and services.*
Digital content creation	Developing digital content	*To create and edit digital content in different formats, to express oneself through digital means.*
	Integrating and re-elaborating digital content	*To modify, refine, improve and integrate information and content into an existing body of knowledge to create new, original and relevant content and knowledge.*
	Copyright and licences	*To understand how copyright and licenses apply to data, digital information and content.*
	Programming	*To plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task*
Safety	Protecting devices	*To protect devices and digital content, and to understand risks and threats in digital environments. To know about safety and security measures and to have a due regard to reliability and privacy.*
	Protecting personal data and privacy	*To protect personal data and privacy in digital environments. To understand how to use and share personally identifiable information while being able to protect oneself and others from damages. To understand that digital services use a "Privacy policy" to inform how personal data is used.*
	Protecting health and well-being	*To be able to avoid health-risks and threats to physical and psychological well-being while using digital technologies. To be able to protect oneself and others from possible dangers in digital environments (e.g. cyber bullying). To be aware of digital technologies for social well-being and social inclusion.*
	Protecting the environment	*To be aware of the environmental impact of digital technologies and their use.*
Problem solving	Solving technical problems	*To identify technical problems when operating devices and using digital environments, and to solve them (from trouble-shooting to solving more complex problems).*
	Identifying needs and technological responses	*To assess needs and to identify, evaluate, select and use digital tools and possible technological responses and to solve them. To adjust and customise digital environments to personal needs (e.g. accessibility).*
	Creatively using digital technologies	*To use digital tools and technologies to create knowledge and to innovate processes and products. To engage individually and collectively in cognitive processing to understand and resolve conceptual problems and problem situations in digital environments.*
	Identifying digital competence gaps	*To understand where one's own digital competence needs to be improved or updated. To be able to support others with their digital competence development. To seek opportunities for self-development and to keep up-to-date with the digital evolution.*

Table 2 – Competence declaration

Each competence has 4 levels of mastery: Basic, Intermediate, Advanced and Highly Specialized. Each level of mastery is explained through a declaration of behaviour (according to Bloom's taxonomy). In addition, each level includes both the cognitive aspect and the skills

and attitudes. Each competence has a specific scenario and different behaviours are described according to the level of mastery, see an example in Table 3:

Area	Competence	Foundation	Intermediate	Advanced	Highly specialised
		I have been involved in a working group to develop a project and I have to use digital			
Communication and collaboration	**Interacting through digital technologies**	Alone or with the help of a more experienced person than me, I can identify which digital communication tools are suitable for my team work (e.g. Facebook or WhatsApp messenger)	Independently, in addition to what has been said before, I am able to interact with my colleagues through the apps on my smartphone or pc (e.g. Facebook or WhatsApp messenger) to organize work	In addition to the above, I provide support to my colleagues and I am able to choose specific options within the communication tools used (e.g. create a WhatsApp group and administer it)	In addition to the above, I am able to support the group in the realization of an online meeting, creating invitations and managing any problems that may arise.

Table 3 – Example of competence and behaviour's description for each level

4. Methods

4.1. Measures

Teachers' mastery of digital skills can be influenced by several factors, internal and external. Rivoltella (2006) states that the poor digital integration in the school can be explained by two different obstacles: the first one concerns external obstacles, such as the lack of time or technological tools at school, the difficulty in procedures accessing, the second one relates to internal obstacles, such as beliefs, attitudes (Benigno et al., 2013). Furthermore, personal characteristics of teachers such as self-esteem, self-efficacy, personality, motivation, needs and self-concept have a decisive influence on the readiness and willingness to change (Benigno et al., 2013; Davis, 2002; Etmer, 2005; Webb, 2002).

Considering the available literature, in order to validate our tool, we administered to the sample a battery of psychometric tests related to internal variables that can influence digital competences and move in a similar way.

Intrapersonal Technology Integration Scale (ITIS) (Benigno et al., 2013). Many researches have shown that the perception of personal self-efficacy on technology considerably affects the integration of technology into one's personal and professional life (Niederhauser, Perkmen, 2008; Faseyitan, Libii, & Hirschbuhl, 1996; Milbrath & Kinzie, 2000). The questionnaire, in the Italian version, is composed of 21 items that measure the constructs of self-efficacy (SE), the expectations regarding the outcome (Outcome Expectations, OE) which is divided into Performance, Social and Self- Evaluative OE and the construct of interest (Interest, INT) in the use of technologies (previously theorized within the Social Cognitive Career Theory by Lent et al., 1994). Respondent can indicate their level of agreement or disagreement on a five-level Likert scale (from 1 = strongly disagree to 5 = strongly agree).

Utrecht Work Engagement Scale (UWES) (Pisanti et al., 2008). As reported by Schaufeli & Bakker (2004), involvement in work provides a sense of connection and energy that allows workers to effectively meet the demands of their work, thanks to the three elements of vigor, dedication and involvement. Engaged workers have more resilient tools and ways to cope with changes in the context, such as the ongoing digital transformation and the demand for digital integration in teaching practice. The scale consists of 17 items that identify the three elements of vigor, dedication and involvement. Respondent can express the frequency he/she experiences certain feelings related to work on a 7-point likert scale (never to always).

Teacher self-efficacy scale (SAED) (Biasi et al., 2014). "The teacher's perception of self-efficacy corresponds to the judgment on personal abilities to be able to achieve the desired results in terms of commitment and learning by students. This construct has shown to be

strongly linked to many significant educational achievements including: persistence, enthusiasm, commitment and teaching behaviour of the teacher; and, as a decidedly important secondary effect, it has shown a predictive value on students' learning outcomes, their motivation and their beliefs regarding self-efficacy". (Biasi et al., 2014, p. 491). The Italian version of the scale includes 24 statements and respondent can declare her/his level of agreement with a scale from 1 to 9, where 1 indicates "not at all" and 9 "very much".

The Multidimensional Work Motivation Scale Motivation (WTMTS) (Gagnè et al., 2014). This scale is composed by 15 statements that measure the construct of motivation, in accordance with the Deci & Ryan's self-determination theory (2000). According to the authors, motivation is a multidimensional concept that is measured on a continuum, where on one side there's autonomy (intrinsic motivation) and on the other side the control (no motivation). The higher the intrinsic motivation level is the greater the individual's well-being and performance, while a motivation guided by external inputs or a-motivation lead to lower levels of well-being. Each item is rated on a 7-point scale ranging from 1 ("does not correspond at all") to 7 ("corresponds completely").

4.2 Sample and descriptive characteristics

Participants were recruited via email and responded voluntarily, signing an informed consent and giving permission to process data and report results in an aggregate form. A socio-demographic questionnaire has been administrated in order to identify relevant variables that could influence the subsequent data analysis.

The best sample size to carry out a factor analysis varies between 30 and 500 units (Roscoe, 1975). In addition, from 5 to 10 observations for each variable are needed (Hair et al., 2010). In this study the following indices (among others) to evaluate the closeness of the hypothetical model to the empirical data, multiple goodness-of-fit indexes were used: Tucker–Lewis index (TLI), comparative fit index (CFI), root mean square error of an (RMSEA), and root mean square residual (SRMR). For a model with acceptable quality, it was recommended the following threshold values: RMSEA $\leq$ 0.08, SRMR $\leq$ 0. 08, TLI $\geq$ 0.95, CFI $\geq$ 0.95 (Balog, 2015).

After the data screening and check for disengagement/content free bias, the dataset consisted of 351 respondents with a mean age of 38.6 years (SD = 9.1), 78% of whom were females, and left skewed level of education (73.21% with MA degree or higher, 17.94% have a Bachelor's degree and only 8.83% have a diploma). Regarding the teaching profession, 47.86% actively carry out the role of teacher, both in role and out of role, a proportion considered suitable for the study considering that the scale in validation focus on digital citizenship competencies that should also appertain to still on training teachers.

Concerning the knowledge of technology (self-evaluation through single item), the sample declares to have an intermediate knowledge for 43.87% and advanced for 40.74%. Only 63.81% of the sample has attended a training course on technological aspects. This constituted a key element because digital citizenship competency is theoretically related to IT literacy, and the latter is a necessary condition to improve the former. Therefore, we run a series of statistical tests on possible confounding variables to evaluate possible significant differences between the respondents who previously attended IT courses and the others and avoid biases: age , education level . Lastly, a one way ANOVA was run on QCCD_TOT total with "job and role" variable as independent for the three conditions [$F(2,348) = 0.170$, $p = .843$].

These statistics confirmed the absence of distortions due to socio-demographic characteristics (as reported all the test statistics were statistically not significant).

5. Validation Study

To test and verify the unidimensionality of the scale, two analyses were conducted: (a) an exploratory Factor Analysis, (b) a Confirmatory Factor Analysis. First exploratory factor analysis on a smaller randomly extracted sample to see the factor structure and decide on a one

or multiple factor solution and then CFA to test the fit of the latent model. Before the exploratory factor analysis, Bartlett test of sphericity was used to ensure significant correlation (if the variables are unrelated are also unsuitable for structure detection) and Kaiser-Meyer-Olkin test (KMO) to evaluate the proportion of variance in the variable set that might be caused by underlying factors.

The KMO measure of sampling adequacy was 0.948, far above the commonly recommended value of 0.600. Bartlett's test of sphericity (test of at least one significant correlation between 2 of the items studied) was also significant . Therefore, factor analysis was regarded to be suitable with all the 21 items/questions.

The initial exploratory factor analysis was performed without any restriction on the number of metric factors to be estimated, maximum likelihood factoring and Promax with Kaiser normalization were used, and only factors with eigenvalues greater than 1 were included. It yielded one factor with eigenvalue 9.801, which is over Kaiser Criterion of 1, explaining 46.7% of the total variability, therefore the QCCD_TOT scale appeared to have a unidimensional structure and it suggests one factor as the optimal usable model.

Subsequently, a Confirmatory Factor Analysis (CFA) on the whole sample was performed to study the replicability of the factor structure obtained by EFA. CFA showed satisfactory goodness of fit indices for the hypothesized one-factor structure. Chi square (= 388.8, df = 189, p < .001) value and very positive goodness of fit indices (CFI = .988, TLI = .0987 SRMR = 0.069, RMSEA = 0.055) suggested that the model is coherent with the data. A second CFA was run to assess the presence of a second-order factor of digital citizenship literacy (with five factors for AREAS) checking the possibility of a model with better fit to the data but still coherent with theoretical framework. Likewise, this model presented acceptable goodness of fit indices: Chi square (= 213.8, df = 184, p < .066) value and very positive goodness of fit indices (CFI = .998, TLI = 0.998 SRMR = 0.051, RMSEA = 0.021).

Overall, the one factor model was evaluated as appropriate to maximize the explained variance of endogenous latent constructs (dependent variable) and minimize the unexplained variances (whereas adherent to the theoretical design of the scale), considering that the second-order model increased fit indices statistics were not so relevant when compared to the more complexity of the structure.

Fit indices

Index	Value
Comparative Fit Index (CFI)	0.988
Tucker-Lewis Index (TLI)	0.987
Bentler-Bonett Non-normed Fit Index (NNFI)	0.987
Bentler-Bonett Normed Fit Index (NFI)	0.978
Parsimony Normed Fit Index (PNFI)	0.880
Bollen's Relative Fit Index (RFI)	0.975
Bollen's Incremental Fit Index (IFI)	0.988
Relative Noncentrality Index (RNI)	0.988

Chi-square test

Model	X^2	df	p
Baseline model	17432.504	210	
Factor model	388.780	189	6.661e−16

Other fit measures

Metric	Value
Root mean square error of approximation (RMSEA)	0.055
RMSEA 90% CI lower bound	0.047
RMSEA 90% CI upper bound	0.063
RMSEA p-value	0.144
Standardized root mean square residual (SRMR)	0.069
Hoelter's critical N (α = .05)	200.924
Hoelter's critical N (α = .01)	214.492
Goodness of fit index (GFI)	0.985
McDonald fit index (MFI)	0.752
Expected cross validation index (ECVI)	1.351

Figure 2. CFA Fit indexes – Factor model of QCCD scale

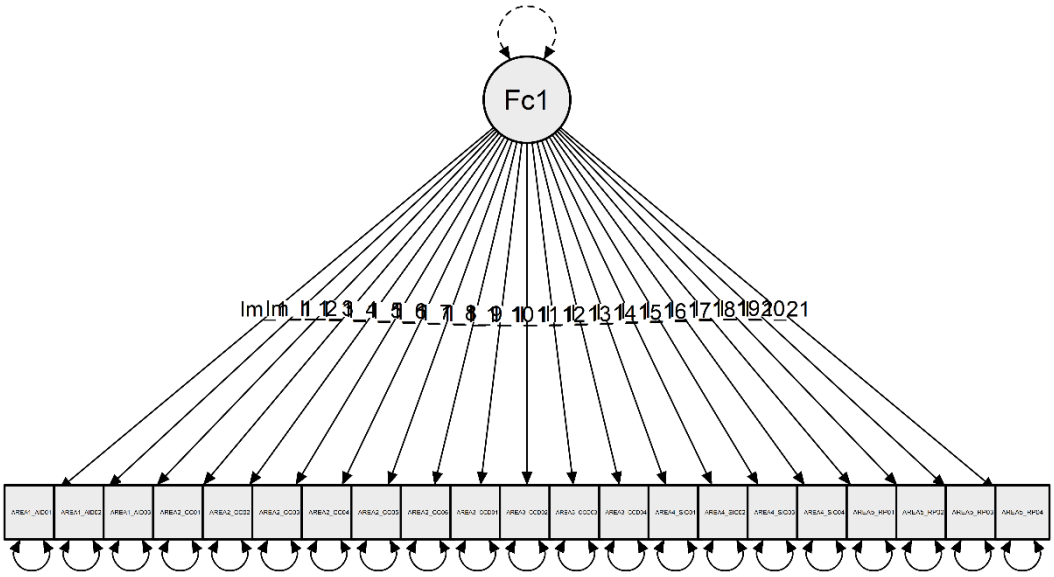

Figure 3. Model plot – Second order factor model of QCCD scale

After Confirmatory Factorial Analysis, different types of validity (i.e., content and construct validity) were investigated. Specifically, regarding content validity the five subscales of the QCCD scale test were correlated with each other and with the total of the QCCD tool itself. (Cronbach, L. J., & Meehl, P. E., 1955). As shown in table XXX, Perason's correlation coefficients were stronger among AREA 5-Problem Solving & AREA 4-Security & AREA 3-Digital Content Creation, and a similar trend is noticeable between AREA 1-Information and Data Literacy & AREA 2-Communication and Collaboration. This pattern of relationship is coherent with the theoretical design of the measurement tool and in combination with the robust correlation between subscales and QCCD Total scale supports the content validity of the questionnaire itself.

Variable		AREA1_AID_TOT	AREA2_CC_TOT	AREA3_CCD_TOT	AREA4_SIC_TOT	AREA5_RP_TOT	CittadinanzaDigitale_TOT
1. AREA1_AID_TOT	Pearson's r	—					
2. AREA2_CC_TOT	Pearson's r	0.687***	—				
3. AREA3_CCD_TOT	Pearson's r	0.501***	0.684***	—			
4. AREA4_SIC_TOT	Pearson's r	0.565***	0.645***	0.603***	—		
5. AREA5_RP_TOT	Pearson's r	0.545***	0.713***	0.753***	0.713***	—	
6. CittadinanzaDigitale_TOT	Pearson's r	0.759***	0.904***	0.839***	0.831***	0.881***	—

* p < .05, ** p < .01, *** p < .001

Table 4. Pearson's correlation regarding content validity

Consequently, to verify construct validity, the ITIS subscales of Self-Efficacy (a measure of the level of confidence perceived by the subject in the use of ICT in the classroom) and Interest in instructional technology were examined and found to be similarly correlated with all areas, confirming the theory that sees these constructs as transversal to areas of expertise.

Variable		AREA1_AID_TOT	AREA2_CC_TOT	AREA3_CCD_TOT	AREA4_SIC_TOT	AREA5_RP_TOT
6. ITIS_SE	Pearson's r	0.433***	0.582***	0.531***	0.484***	0.632***
7. ITIS_POE	Pearson's r	0.194***	0.322***	0.285***	0.303***	0.368***
8. ITIS_SEOE	Pearson's r	0.123*	0.251***	0.248***	0.241***	0.314***
9. ITIS_SOE	Pearson's r	0.018	0.135*	0.220***	0.152**	0.248***
10. ITIS_INT	Pearson's r	0.247***	0.376***	0.327***	0.319***	0.388***

* p < .05, ** p < .01, *** p < .001

Table 5. Perason's Correlation between IT IS subscales and QCCD subscales

The QCCD subscale "Area 5 - problem solving" is the one that correlates (overall) most significantly with the set of scales of the ITIS and this was theoretically expected because the attitude towards educational technology has a strong connotation towards the resolution of critical issues. Differently, regarding discriminant construct validity a very weak correlation ($r = 0.146$ although statistically significant $p < .01$) was found between UWES total scale and QCCD total scale, also an evidence of construct validity because digital citizenship literacy is not directly linked to work motivation.

Overall, QCCD_TOT scale (21 items) showed an extremely strong internal consistency considering the value of the Cronbach's was equal to 0.947. In addition, the Cronbach's was evaluated after deleting individual items for each subscale and all the items contributed significantly (). Overall, the internal consistency of the 21-item QCCD scale was satisfactory.

5.1 Limitations

Regarding the few limitations of this study, the presence of a convenience sampling has to be addressed, therefore it may not be as representative of the reference population (inference to the Italian teacher population may be biased). Furthermore, even if the internal coherence of the scale was analyzed, it would be important to analyse stability as a complementary measure of reliability. Lastly, the proportion of female respondents outrank the male one, and this fact also may interfere with results' inference, although a similar difference in gender is also present in the teacher population.

Conclusions

Results of the analysis support the validity and reliability of QCCD scale in measuring the objective construct: digital citizenship literacy. Confirmatory factor analysis confirmed the hypothesized second-order factorial model. The factorial structure evaluated by jointly considering its overall adequacy and parameter appropriateness clearly indicates how the model is very capable of reproducing the observed data. Internal consistence was confirmed by reliability analysis, while content and construct validity successfully completed the validation study of the scale.

The development and validation of QCCD scale will serve as a tool to evaluate the teachers' digital citizenship literacy, and consequently their proficiency and adequacy to teach this new set of skills to students in school. In a broader research perspective, it would be important to use the scale in the design of an experimental/quasi experimental study. In this case the tool would measure the research results of a psycho-educational intervention carried out on teachers with regard to Digital Citizenship skills, possibly based on principles identified in the evidence-based neuroscientific literature in relation to adult Education. As known, teachers are constantly involved in didactic activities and it's difficult for them to gain time for training but also schools' financial resources are scarce. This leads to putting training and development needs in the background. With digital transformation and new scenarios it is mandatory to adapt the skills of those who are at the forefront of the healthy development of digital citizens. We believe that QCCD for Teachers may be useful in planning tailor-made teacher's training, based on gaps detected instead of generalized training needs. In this way, the professional development efforts will be more sustainable by teachers and institutions with time and cost savings.

In addition, this study sheds light on the policies that should be established at system level

to endorse the digital citizenship through the whole Educational System and ultimately to the Italian population. The training of the future teachers or professionals should be done in the light of sustainable development (Education, Audiovisual and Culture Executive Agency, 2017) amplifying the awareness toward ICT role in the life of future citizens.

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