Design and validation of an instrument to measure the self-perception toward the use of Digital Technologies and Active Methodologies in Initial Teacher Training

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Abstract:

One of the challenges facing teacher training is to provide opportunities for the appropriation of digital technologies (TD) and their relevant use for the promotion of Active Methodologies (AM). In this sense, the present study addresses the design and validation of a survey to measure the self-perception of teacher educators for the implementation of AD with DT. A brief theoretical and empirical support is presented, as well as the validation of the instrument by expert judgment. With a sample of teachers from Chile, Mexico and Venezuela, a pilot test was applied, with the results of which the reliability analysis and the exploratory factor analysis of the instrument were carried out. The product obtained corresponds to a survey consisting of 6 dimensions and 48 items, which may be useful for the study of the self-perception of teacher trainers towards the use of TD to favor active learning in future teachers.

Keywords: Survey 1, Self-perception 2, Active Methodologies 3, Digital Technologies 4, Initial Teacher Education 5, Teacher Training 5.

DOI Number: 10.14704/nq.2022.20.9.NQ44571 Neuro Quantology 2022; 20(9):4923-4942

1. Introduction

Today's society is characterized by the accelerated growth of Digital Technologies (DT) with the massification of the use of smart devices and access to information, social networks and audiovisual entertainment (ECLAC, 2021). In the 1990s, it was already suggested that the use of these technologies in education could become an important aspect of the establishment of a new learning paradigm (Tapscott, 1997). Today, however, the need to innovate and use technologies in an appropriate way to teach and learn in this era is still latent (Shagiakhmetova *et al*., 2022; Lukianova, 2022; Martínez & Fierros, 2022).

Along with the challenges that come with the evolution of technology and knowledge, the teaching task has been one of the most controversial aspects, since there is still talk of a traditional education that somehow has not ceased to be present in the thinking and actions of teachers. Under this conception, the student is a mere receiver of information (Medina Rubio, 1992; Rogers, 1972), and is considered similar to a "bank" in which knowledge is "deposited" so that he memorizes, accumulates and repeats the information without great efforts to reason (Freire, 1987).

In contrast, there are other views of education as a liberating practice (Freire, 1987), democratic (Rogers, 1972), and participatory (Ontoria *et al*., 2012), among others, that defend the promotion of meaningful learning, that is, learning that acquires real meaning for the learner, which is becoming urgent and challenging in "our volatile world of instantaneous and erratic change" where "established customs, solid cognitive frameworks and preferences for stable values, those ultimate objectives of orthodox education, become disadvantages" (Bauman, 2008, p. 37).

In this order of ideas, to this set of views is added a critical view about the relevance given to TD for teaching and learning, considering, in turn, the student as the main actor of the process,

especially when it comes to future teachers (Basilotta-Gómez-Pablos et al., 2022; Grassinger *et al*., 2022; Istiningsih 2022; Örtegren, 2022; González *et al*., 2020; Cabello *et al*., 2020; Cabero & Martínez, 2019), training in which the pertinent use of TDs should not leave aside the history of education, the ethical valuation of the purposes of human development and democratic social coexistence (Meirieu, 2022).

2. Materials and Methods

2.1. Literature review

2.1.1. Digital Technologies in Initial Teacher Education

With the emergence of new digital media, sophisticated forms of communication and interaction also arise, which to a greater or lesser extent are causing changes in the way knowledge is produced and approached. Faced with this reality, teachers must be adequately prepared to implement these types of tools without fear of using them (Záhorec *et al*., 2021). Despite this, studies demonstrate some aspects that draw attention to the use of TDs in teacher training.

In the integration of TD in the current study programs of all Basic and Secondary Pedagogy careers in Chile, for example, four modalities have been found, namely: a) Exclusive integration in graduate profiles, 16%; b) Exclusive integration in subjects, 26.2%; c) Integration in both profiles and subjects, 22.7%; and, d) No integration at all, 35.1%, (Cabello *et al*., 2020). In the opinion of the authors who conducted the research, the results indicate that a high proportion of curricula do not integrate technologies at all, evidencing the requirement for advanced digital competencies and the development of skills for their implementation in the classroom.

In Spain, a comparative description was made of teaching competencies for languages and the use of technologies, and their relevance for teachers' access to the labor market. The comparison was made with other professions using data from the 2019 Labor Market Insertion Survey of University Graduates. The results showed that teachers have a higher level in both competencies than other professionals in the social welfare system, but STEM (Science, Technology, Engineering and Mathematics) professional teachers have a much higher level. Thus, together with language proficiency, one of the notable recruitment factors in the educational system of that country is training in technologies, so the university system responsible for teacher training is obliged to provide them with a higher level of this competence with a view to the effective incorporation of technological tools in their teaching-learning processes (Rodríguez *et al*., 2021).

In Indonesia, a study conducted with future teachers revealed that even when they use technology and some manage to better understand and explain its adoption and integration in teaching, factors such as lack of time, the complexity of incorporating technologies, limited infrastructure, lack of training and technical support, constitute barriers to optimal integration of technologies in training processes (Habibi *et al*., 2020).

Meanwhile, in Ukraine, from action research on the development of information literacy and digital skills of future foreign language teachers, the need to consider this type of literacy as an important component of teacher training was raised, which, in turn, represents a contribution to the sustainable development of the country (Konovalenko & Navolska, 2020). The same authors claim that during their training, future teachers should become aware of the advantages and disadvantages of using technologies in the classroom, apply criteria for evaluation and selection of online resources, software and applications, and develop the skills involved in the use of software, participate in social networks, blogs, wikis, evaluate the potential of online audios, videos and images. Finally, every teacher must be able to create safe conditions for the use of the Internet and devices, as well as to produce digital content.

2.2.2. Active Methodologies in Virtuality (AMV)

When the teaching and learning process is led by the student, reference is made to Active Methodologies, understood as those that focus on sponsoring the autonomy and responsibility of the learner, qualitatively improving their capacity for reasoning (Bietenbeck, 2014), participation (Labrador & Andreu, 2008), reflection (Torres Carceller, 2019), cooperation, decision making and knowledge construction based on real experiences and situations (Navas-Berbel, 2011; Fidalgo-Blanco *et al*., 2019). Active learning can also be induced by debates, problem-solving and research (Chang *et al*., 2003).

Now, in contexts supported by TDs, the virtual becomes part of the reality of each person; Webcams and cell phones, to mention a few, can be assumed as extensions of human existence together with the world of data available on the network that may well represent the extended memory of each subject (Lanier, 2011); but, in the face of the benefits and possible risks offered by such tools, current curricula are required to emphasize the appropriate use of TDs and the acquisition of digital competencies for greater interaction between students and teachers, for which teachers must "allow students to reflect, explain and actively contribute" by proposing strategies linked to examples and real-world applications through technologies (Hepp *et al*., 2015).

In this framework of ideas, it is worth mentioning that students can count on new forms of socialization (Jaén Martínez *et al*., 2017), instrumental digital competencies (mastery of technology in which the teacher is a beginner, Rodríguez-Espinar, 2015), creative, mobile, multitasking, collaborative skills (Peregrina, 2015). Thus, the virtual as a "different medium" (Sangrà, 2001), can (and should) be configured as "a bridge between different knowledge", a situation in which "connecting knowledge" is emerging as a skill that should be stimulated and developed in those who learn "regardless of their age, their activity or the device they use" (Cobo & Moravec, 2011).

Active Methodologies imply a change of paradigm and their application in virtuality does not neglect this task; for this, experiences that make possible "an explicit analysis of the restrictions and implicit rules that ICTs themselves impose" are required (Monereo & Pozo, 2008). Among the active methodologies that have been used in virtual contexts, especially at the university level, are Problem-Based Learning, Project-Based Learning, Gamification, the inverted classroom or Flipped Classroom, design thinking or Design Thinking (Roig-Vila & Álvarez-Herrero, 2019).

Problem-Based Learning has its origin at McMaster University, Canada with its application in chemistry and medicine classes in the 1960s (de Graaff & Kolmos, 2007). Project-Based Learning, on the other hand, has as its antecedent the Project Method proposed by Kilpatrick in 1921 (Campos, 2017). Both strategies propose the beginning of the teaching-learning process with the proposal of a problem to stimulate student learning (Prince & Felder, 2006).

Among the experiences related to the application of these methodologies in initial teacher training, there is the design of a module considering Learning Based on the sustainable development of reaction kinetics, aimed at 22 chemistry teachers in training in Chile; the methodology used promoted the acquisition of knowledge of chemistry and pedagogy together with the development of skills and abilities in the use of technologies for teaching and learning in scientific contexts and the resolution of problems in the real environment (Cáceres-Jensen *et al*., 2021).

In Indonesia, in the development of a course for trainee physics teachers supported by the use of technology, industrial developments, educational research and Project Based Learning, the following results were obtained: in the implementation stage, students were able to design an e-book and perform simulation, animation, motion worksheet, create and manage a YouTube channel, create an account and generate questionnaire in Kahoot and designs for the augmented reality marker, so it was recommended the implementation of curricula supported by the use of technologies aimed at both in-service physics teachers and trainee teachers to optimize their performance (Budi *et al*., 2019).

About Design Thinking (DT), even though it did not originate in the academic world, it has been implemented in this field in recent years. It is based on the human capacity to be intuitive, recognize patterns, build ideas that have emotional meaning, are functional and are useful for expression through words and symbols. It is conceived as a system of overlapping spaces with three spaces to consider: inspiration (problem or opportunity that motivates the search for solutions), ideation (the process of generating, developing and testing ideas) and implementation (ideas generated during ideation are converted into a concrete and fully conceived plan of action whose center is prototyping); in this methodology, ideas become real products and services that are then tested, iterated and refined (Brown & Wyatt, 2010).

In the United States, DT methodology was used for a virtual exchange aimed at introducing 36 pre-service teachers to global collaboration and

empowered learning through the use of technology and the application of design thinking principles (empathy, ideation, and testing) that were aligned with broader educational goals of culturally responsive and metacognitive practices; participants leveraged technology to achieve learning objectives based on their strengths, collective interests, and problem-solving strategies (Gleason & Jaramillo Cherrez, 2021).

Using the same methodology, 76 prospective teachers participated in a Creative Technical Workshops elective course experience at the Faculty of Education, the University of Ljubljana in Slovenia with results revealing significant differences ($p < 0.05$) in pre-/post-test scores on most design thinking constructs and further demonstrated that methodology supported by transformative learning theory can be conducive to developing higher thinking skills and meaningful learning experiences; based on the results, a model could be created to facilitate pedagogical change in the context of higher education across different curricula (Avsec, 2021).

On the other hand, there is gamification, defined as the application of game resources, such as mechanics, elements, techniques, dynamics, etc., in non-game contexts with a non-game context (Avsec, 2021). In non-game contexts to modify behaviors of individuals and involve them in problem-solving using attractive components, in various fields (Zichermann & Cunningham, 2011; Teixes, 2015; Araújo & Carvalho, 2022); for other authors, gamification is more linked to the design of video games and seeks to influence behavior through motivation (Quintás, 2020).

In Chile, a training model for the development of classroom verbal interaction strategies was implemented with 124 student teachers from two Chilean universities: public and private, combining face-to-face classes and a digital game; after five weeks of intervention, a significant increase was observed in the recognition, analysis and design of verbal classroom interactions of the students, finding statistically significant differences according to university and specialty, but not by gender or socioeconomic level. Other findings had to do with the positive relationship between the use of the game outside the classroom and the ability to analyze and design classroom interactions and the good valuation of the training module by students, which leads to suggest the use of gamification to strengthen teacher training by taking advantage of the opportunities provided by digital technologies (López-Neira *et al*., 2020).

A study conducted in Mexico aimed to check whether gamification strategies in a distance course aimed at 31 future teachers were considered innovative educational practices, according to the elements of the educational model of the training institution and the perception of the participants; the course design included three basic gamification strategies: narrative, escape room and "PET triad", finding that the institutional model allows the development of activities framed in gamification, and, the opportunity to offer learning experiences enriched with new ways of learning and the development of behaviors such as motivation and teamwork (Reyes & Quiñonez, 2020).

The inverted classroom or Flipped Classroom is another of the methodologies linked to active learning. In this pedagogical approach, the lesson is made available to students before class, so direct instruction takes place in the individual learning space; then, the teacher guides students as they apply the concepts and can participate creatively in the process (Flipped Learning Network, FLN, 2014; Cueva & Inga, 2022).

In a didactics course aimed at 31 future physics teachers in Chile, the flipped classroom was implemented on virtual platforms; after the experience, participants reported having developed habits of self-regulation for learning; they also claimed that the constant need to review materials before class was difficult, but at the same time they stated that the timely management of different contents by the teacher favored deep and reflective learning and, awareness regarding the commitment to their learning and the development of better study habits (Hernández-Silva & Tecpan, 2017).

In another research developed in China, 77 trainee teachers participated in an experience in which they were divided into two groups, an experimental group received the flipped classroom treatment and in the control group the traditional lecture-centered instructional en-approach was maintained; the evaluation was conducted through practice tasks, transfer tasks and student perception surveys. The results revealed that the experimental group showed

better learning achievement, satisfaction, self-efficacy and motivation compared to the control group (Zhao *et al*., 2021).

Another methodology frequently used in education is the Case Study or Case Method as a teaching and learning strategy. "Cases are complex educational tools that take the form of narratives", they are built around a problem or "big ideas" (Wassermann, 1994, p. 19).

In Ukraine, 167 prospective teachers of foreign languages and cultures participated in activities connected with the case study method, test method, game method, project-based method and information and communication technologies, the usefulness of these methods for the promotion of students' methodological skills was corroborated, as they managed to promote analysis, correction of errors and creation of lesson plans for the integrated development of linguistic, discursive, sociocultural and strategic competencies (Maiier & Ustymenko, 2018).

Another research in Germany aimed to examine whether training with video-based, transcript-based or blended media-based learning cases showed different effects in promoting specific classroom management skills; 162 trainee teachers were assigned to three intervention groups. The results showed that the combination of videos and transcripts was more effective, the work with videos was also perceived to be favorable for greater cognitive activation, thus demonstrating the usefulness of TDs for the implementation of Case Method strategies (Kramer *et al*., 2020).

2.2. Instrument: Survey

For the design of the instrument, some modifications were made to the Questionnaire of Self-Perception of Digital Teaching Competence, CACDD (Esteve, 2015). The changes were made taking into consideration the ICT Teaching Competencies Framework of the United Nations Educational, Scientific and Cultural Organization, UNESCO (2019) and the literature review.

The following dimensions were proposed, each with 8 items:

- Meaningful learning, experience and creativity;

- Management and adaptation of TD to students' characteristics;

- Optimization of teaching work with TD;

- Digital citizenship;

- Commitment to continuous professional improvement; and

- Methodologies for Active Learning

The instrument was structured in two sections, one section for demographic data, and a second one with the items proposed for each dimension. The demographic data present in the survey correspond to country (Chile, Mexico, Venezuela), gender, age, years of service, type of institution (public or private), academic level (Bachelor's Degree/Professor, Specialization, Master's Degree, Doctorate), subject(s) taught. In the items section (48 in total), a continuous eight-point Likert scale from "not at all capable" (1) to "very capable" (8) was maintained, as contemplated in the CACDD.

2.2.1. Content Validity and Reliability

Content validity is useful to verify how adequate, relevant and representative the items of an instrument are (Cohen & Swerdik, 2001). For the validation of the survey, the judgment of 5 Doctors in Education who acted as expert evaluators was used; their selection was based on the following criteria: experience in this type of validation and decision-making based on evidence or expertise; reputation in the scientific community; availability and motivation to participate in the process; impartiality; and similar education and experience (Rubio *et al*., 2003; Summers *et al*., 2004).

The experts who participated in the process have extensive experience in research related to teacher education and work professionally in Chile (2), Venezuela (2) and Ecuador (1). A form was designed in Google Form (https://forms.gle/32TxvfkVjfJz6h3e7), in which the purpose of the instrument was informed, and the dimensions with their corresponding items were shown. Each judge indicated his or her agreement or disagreement as to the relevance, comprehension and pertinence of each item; in addition, a writing field was incorporated in each dimension for the experts to express comments, observations and/or recommendations in each of them.

The concordance or agreement between the judges was verified by calculating the following coefficients: a) Fleiss' Kappa (Fleiss' K), b) Content Validity Ratio (CVR) applying the model

proposed by Lawshe in 1975, and c) Adjusted Content Validity Ratio (CVR') presented by Tristán-López in 2008.

Fleiss' K is proposed when it is required to measure the degree of agreement in more than two judges or experts (Fleiss *et al*., 2003). CVR is used when there are 5 or more experts (Lawshe, 1975), and CVR' is a modification of the previous coefficient "that overcomes its limitations" in terms of requiring a large number of judges to reach a satisfactory value (Tristán-López, 2008).

The three coefficients have been used in various investigations in the educational field. For the application of the Delphi method in the design of a framework for competency-based learning, the analysis of agreement among experts was performed with the three coefficients mentioned (Sánchez-Tarazaga & Ferrández-Berrueco, 2022). Other research reports the use of Fleiss' K in an instrument proposed for the evaluation of the level of diabetes knowledge of school teachers (Luque-Vara *et al*., 2020) and, in an in-depth interview guide on the development of digital competence of university teachers (Padilla-Hernández *et al*., 2019).

The CVR has been applied in cases such as Content Validation of a module to assess school readiness in children with autism spectrum disorder (Mukkiri *et al*., 2022); perceptions of Basic Education teachers in Spain about their initiation to teaching and how that process of insertion into professional practice should be (Manso & Garrido, 2021); effect of the inverted classroom on Iranian adolescents (Izadpanah *et al*., 2021); validity and reliability of the Self-Perception Profile for Adults in the educational setting (Jiménez-Díaz *et al*., 2018).

The CVR' has been used in studies of literacy in higher education (González *et al*., 2021), reading motivation for Language and Communication teachers (Jodeck-Osses *et al*., 2021), the satisfaction of students of Internship in Education (Ruiz-Gutiérrez *et al*., 2021), teacher training (Hernández & De Barros, 2021), in-service biology teacher's beliefs about biology teaching preparation and its relationship with some dimensions of teacher evaluation (Ravanal *et al*., 2018), information of the educational software CmapTools in the development of critical thinking of university students (Sánchez & López, 2016), and information literacy in higher education institutions (Toledo & Maldonado, 2015), among others.

To carry out the reliability calculation of the survey, an invitation was sent via email to teachers in initial teacher training in Chile, Mexico and Venezuela. The criteria established for their participation were the following: to work professionally in education careers in a public or private institution and to have some experience in the use of TDs.

2.2.2. Exploratory Factor Analysis

To corroborate the proposal of 6 dimensions and their corresponding items, exploratory factor analysis in SPSS was used. This type of analysis is only appropriate when adequate values are met in the following assumptions: the KMO test and Barlett's test of sphericity (Hair *et al*., 1999).

Principal Axis Factorization was used as the extraction method and oblimin oblique rotation, taking into account the theoretical basis of the study, according to which the variables involved are related from a conceptual point of view (Fabrigar *et al*., 1999).

To confirm the variance explained, the extraction of 6 factors was carried out, whose cumulative percentage must exceed at least 60% to conclude that the proposed model is adequate (Hair *et al*., 1999).

Regarding factor loadings, a minimum value of 0.40 was assumed (Bandalos & Finney, 2010), and, exceptionally, values greater than 0.35 (Gorsuch, 1983 and Kline, 1994).

2.3. Sample

The sample consisted of 19 teachers from Chile, 30 from Mexico and 40 from Venezuela, for a total of 89 teachers, with an average age of 39.6 years and an average of 7.7 years of service in teacher training; 53 of them belonged to a public institution in their country, and 36 to the private sector (Table 1)

Table 1. Muestra de docentes (n=89)

Genre	Country			Age ($\bar{x}$)	Years of service ($\bar{x}$)	Type of institution	
	Chile	Mexico	Venezuela			Public	Private
Female	10			38.2	5,8	4	6
		17		38.5	7	12	5
			25	36.7	5,8	18	7
Male	8			42.9	11.6	4	4
		13		42.8	8	7	6
			14	42.2	9.9	8	6
He prefers not to say	1		1	36.0	6		2
Total	19	30	40	39.6	7.7	53	36

3. Results

3.1. Validation of the survey by expert judgment

The results obtained with Fleiss' K (K) and CVR' allowed affirming that there is a very good degree of agreement among the experts in each of the criteria in general (Table 2). However, the criterion related to Comprehension obtained the lowest values K=0.6024 and CVR'=0.9643; although with these values the criterion has a good agreement, each of its items was analyzed, emphasizing those that obtained a CVR value lower than 0.99, and those that were located in a slight or acceptable scale in Fleiss' K. For the analysis, the comments and observations issued by the experts on each of the items involved were considered, all to optimize Comprehensibility, a criterion that has to do with the "understanding of what is meant when reading or interpreting the item" (Cruz & Muñoz, 2015, p. 452).

Table 2. Concordance among experts (n=5)

Coefficient	Criteria		
	Relevant	Understandable	Relevant
K for Fleiss *0.00 Poor;* *0.10-0.20 Mild;* *0.21-0.40 Acceptable;* *0.41-0.60 Moderate;* *0.61-0.80 Considerable;* *0.81-1 Almost perfect* *Landis & Koch (1977)*	The items obtained values ranging from 0.40 to 1.00.	Mild Items: 9, 38 (K=0.20) Acceptable Items: - Academic Level, Experience, 4, 5, 6, 11, 23 (K=0.30). - 16, 17, 18, 25, 26, 32, 37, 40 (K=0,40) The rest obtained values ≥ 0.60.	The items obtained values ranging from 0.40 to 1.00.
CVR. For 5 judges each item must obtain a value of ≥ 0.99. *Lawshe (1975)*	The items obtained a value of "1", except for the item: Gender, which obtained a CVR=0.60.	The items were placed in the value "1", except for the following, which obtained a value lower than "0.99": Gender,	The items obtained values equal to "1".

		Academic Level, Experience, 4, 5, 6, 9, 11, 23, 38 (CVR=0.60)	
CVR'. *Minimum value=0.5823 Tristán López (2008)*	The items exceeded the minimum value, placing them at "1". Gender obtained (CVR'=0.80)	All items exceeded the minimum value: Gender, Academic Level, Experience, 4, 5, 6, 9, 11, 23, 38 (CVR'=0.60). The rest obtained a value of "1"	All items were placed at value "1".
Criteria in general	K=0,6301 CVR'=0,9964	K=0,6024 CVR'=0,9643	K=0,6409 CVR'=1

Regarding the item "Gender", only one of the experts recommended including an additional space for answers other than "Female" or "Male"; the item originally included the option "I prefer not to say", so it was decided not to modify it. In the item "Academic level" two experts recommended adjusting the response alternatives due to possible differences among the countries involved in the study, "the undergraduate academic level is also known as a degree in some countries". Consequently, we proceeded to modify the response alternatives of the item so that it would be understood as accurately as possible according to the existing options in each country.

In the item "Years of experience in initial teacher training", two experts suggested establishing the years by ranges (less than 2 years, from 2 to 6 years, more than 6 years...), however, the decision was made not to modify it to obtain the magnitude of the differences between teachers' years of experience.

For the rest of the items, the following procedure was followed:

- Items 4 to 6. The recommendation of "highlighting the elements of the statement that one wishes to differentiate in each one" by writing them with a capital letter was assumed; this action was applied in all the items of the dimension (items 1 to 8).
- In items 5 and 6, the phrase "social networks" was incorporated when referring to social and collaborative tools.
- Items 9 and 11. The wording was adjusted as it lent itself to "double action" in the same item.
- Items 16, 17, 18, 25, 26, 32, 37, 40. Although the items are accepted based on the three coefficients, an adjustment was made to the general wording of each item based on the recommendations of two experts.
- Item 23. The recommendation to complement the expression "Manage information with TD" with the phrase "for updating content" was accepted.
- Items 38, 39 and 40. The wording was adjusted to emphasize the use of TD in the professional improvement of teachers.

3.2. Reliability of the instrument

Regarding the internal consistency of the instrument, the results obtained in the pilot test allow affirming that the survey is reliable, that is, it has a satisfactory internal consistency from the general point of view with a value of $\alpha = 0.959$. As for the dimensions that make up the instrument, the values ranged between 0.830 and 0.967 (Table 3).

Table 3. Internal Consistency of the Instrument. Cronbach's Alpha Coefficient.

Instrument Dimensions	Value Cronbach's Alpha Coefficient
Meaningful learning, experience and creativity	0.830
Management and adaptation of TD to the students' characteristics	0.967
Optimization of teaching with TD	0.957
Digital citizenship	0.954
Commitment to continuous professional improvement	0.918
Methodologies for Active Learning	0.943

n the corrected total item correlation values, the item-test correlation in questions 1, 2, 4, 5, 6 and 34 was less than 0.40 (Table 4), however, given that with their elimination the value of the coefficient is practically maintained, it was decided to keep them in the instrument; in addition, no negative value or value equal to zero was found.

Table 4. Total correlation of corrected items

Item	Total correlation of corrected elements	Cronbach's alpha if the element has been deleted
1	0.231	0.961
2	0.302	0.960
4	0.295	0.960
5	0.132	0.961
6	0.395	0.960
34	0.221	0.961

3.3. Exploratory Factor Analysis

To carry out the analysis in reference, compliance with the required assumptions was determined, obtaining values that allowed the procedure to be admitted; in the KMO test, a value of 0.756 was obtained, while in the Bartlett's test of sphericity the result was 0.000 (Table 5).

Table 5. KMO and Barlett's Test

Kaiser-Meyer-Olkin measure of sampling adequacy		0,756
Bartlett's test for sphericity	Approx. chi-square	6303,035
	gl	1128
	Sig.	0,000

The total variance explained by the proposed model was 74%, a value that allows us to affirm that the model is acceptable for explaining the total set of data (Table 6).

Table 6. Total variance explained

	Initial self-values			Sums of squared extraction charges			Sums of loads squared by rotation[a]
Factor	Total	% of variance	% accumulated	Total	% of variance	% accumulated	Total
1	17.571	36.607	36.607	17.365	36.177	36.177	10.674
2	6.547	13.640	50.247	6.343	13.215	49.391	8.119
3	4.484	9.342	59.589	4.234	8.821	58.212	9.276
4	3.606	7.512	67.101	3.363	7.007	65.219	6.146
5	2.482	5.171	72.273	2.232	4.650	69.869	9.338
6	2.331	4.856	77.129	2.032	4.233	74.103	7.690

Extraction method: principal axis factorization.

[a]. When factors are correlated, the sums of the squared loadings cannot be added to obtain a total variance.

Regarding the Pattern Matrix, the factorial solution showed the grouping of the instrument variables in 6 factors; the factorial loadings of the items met the criteria for their inclusion in each factor. Each factor was assigned 8 items with a value greater than 0.40 each, except for item 2, which obtained a value of 0.355 in "Factor 4". In the same factor, it was found that item 4 obtained a value of 0.408 and, in "Factor 3" its value was 0.450 (Table 7).

Table 7. Patrón Matrix

	FACTOR					
	1	2	3	4	5	6
V1				0.592		
V2				0.355		
V3				0.757		
V4			0.450	0.408		
V5				0.460		
V6				0.545		
V7				0.866		
V8				0.938		
V9		0.625				
V10		0.840				
V11		0.882				
V12		0.596				
V13		0.849				
V14		0.764				
V15		0.804				
V16		0.801				

V17			-0.770	
V18			-0.660	
V19			-0.542	
V20			-0.750	
V21			-0.846	
V22			-0.706	
V23			-0.748	
V24			-0.768	
V25	0.800			
V26	0.880			
V27	0.786			
V28	0.869			
V29	0.803			
V30	0.563			
V31	0.877			
V32	0.768			
V33				-0.898
V34				-0.474
V35				-0.543
V36				-0.844
V37				-0.653
V38				-0.675
V39				-0.679
V40				-0.656
V41		0.831		
V42		0.598		
V43		0.882		
V44		0.794		
V45		0.838		
V46		0.873		
V47		0.750		
V48		0.829		

4. Discussion

Having demonstrated the concordance among the experts regarding the validity of the survey, as well as its internal consistency and the number of factors applying the Principal Axis Factorization method, the content of the instrument can be detailed in the following terms.

A first factor contains variables related to the safe and ethical use of technologies, as well as the rights and obligations of citizens in this digital era; also included are the positive attitude towards the use of TDs in teaching and learning activities, the use of Internet communication codes, knowledge and learning about other

cultures, and risk prevention in the use of devices, cloud tools and/or access to certain websites. It has been agreed to call this dimension "Digital Citizenship", which encompasses competencies that allow "people to access, understand, analyze and use the digital environment critically, ethically and creatively" (UNESCO, 2020).

A second factor congregates the variables implementation of technological devices for learning; use of technological devices for the creation of digital products; TD activities that are adapted to the interests of my students; TD activities where the student has an active role and research; TD activities that adapt to the diversity of learning styles of the students; TD activities that adapt to the different cognitive levels of the students; use of TD for monitoring and feedback of student learning; diagnostic, formative and summative evaluations of the activities and projects supported by TD developed by the students.

Under the name "Management and adaptation of TD to the characteristics of students", this dimension emphasizes the importance of considering pedagogical aspects and their adaptation to the characteristics of students, as well as technical aspects, accessibility and usability, security and guaranteeing the digital rights of the learner (UNESCO, 2022; INTEF, 2017; ISTE, 2017).

Another factor includes active methodologies, such as Problem-Based Learning, Project-Based Learning, Case Studies or Case Methods, Inverted Classroom or Flipped Classroom, Design Thinking or Design Thinking, Thinking Based Learning or Thinking Based Learning, and, strategies linked to active learning, including Cooperative Learning and gamification.

The use of technologies to implement active learning can favor, among other aspects, collaboration, interactive participation, the ability to solve problems, raise interest and motivation towards learning (Wang, 2018; Shroff *et al*., 2019; and Kanosa *et al*., 2020).

The next factor considers the use of TDs for the enhancement of creative thinking, achievement of meaningful learning, enhancement of critical thinking, activities based on real problems, socialization and collaboration, communication and learning; in that sense, this dimension has been given the name "Meaningful learning, experience and creativity".

The fifth factor, "Optimization of teaching work", groups the following variables: selection and use of the most appropriate hardware and software according to the characteristics of the students, teamwork and collaboration with colleagues using TD, information sharing using TD, communication mediated by TD, information management with TD for content updating, research and learning activities with TD. In this digital era, the role of technologies in the work of teachers is becoming more relevant every day due to their great usefulness for teaching tasks and the aspects inherent to teaching (Lai & Jin, 2021; Díaz-Barriga, 2021).

The last factor obtained is composed of the variables: participation in local and international virtual communities of teachers to continue learning about the use of TD in education, appropriate ways of using TD to communicate and manage information in a community, appropriate strategies for the development and improvement of TD skills of other teachers, applying good practices in the use of TD in the classroom, developing educational research for the use of TD, reflection about strategies supported by TD to continue learning as a teacher, designing strategies using TD to contribute to the development of the digital competence of other teachers and the educational community. Thus, the "Commitment to teacher improvement", the name under which the aforementioned variables have been grouped, implies the need for permanent updating regarding the use of technologies for teaching, learning, research and reflective performance of the teaching profession (Baporikar, 2016; Sancho-Gil & Hernández-Hernández, 2018; McKenney & Visscher, 2019).

The need to respond on time to social demands and changes has been a constant aspect of the educational field. The responsibility of educating citizens in this era is marked by the dynamic and at the same time complex use of digital technologies (DT), against which the role of teachers in teacher training is crucial because they are called to resort to new paradigms in their professional work and, of course, to promote in their future colleagues a rational and relevant use of such tools from the pedagogical point of view. In this context, an important element is the

teacher's self-perception of the use of TDs to favor active learning in their students.

In line with the above, the development of the study and the results obtained allow us to conclude, on the one hand, that the quantitative and qualitative analysis of the judgment expressed by the experts is a strategy that enriches this procedure and, therefore, increases the methodological rigor inherent to the instrument.

The dimensions and their corresponding items proved to have high internal consistency, in addition, the 8 items proposed in each of the dimensions were established and ratified in the conformation of a survey that can be useful to measure the level of self-perception of teachers who work in initial teacher training.

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