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Structural Characterization of Factors for the Digital Training of Public Primary School Teachers: The Peruvian Case

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Abstract– The aim of this study was to determine the key factors of the digital teacher training system in public primary schools, which aims to improve teachers' digital competence. Digital competence is defined as the creative, critical, and safe use of Information and Communication Technologies (ICT) [1]. Worldwide, several countries use within their digital training programs institutional frameworks such as the European Framework for the Digital Competence of Educators, the International Society for Technology in Education (ISTE) and/or UNESCO [2] [3]. In Peru, the Framework for Good Teaching Performance, a guiding document for public teachers, only encourages its use according to the purpose of the learning session. In 2020, the Closing Digital Divide strategy revealed that 81% of public teachers required training to integrate technologies into their pedagogical practice. This study used structural analysis to analyse key factors in teachers' training to improve their digital competence. Results showed that among the key factors of the training system were the differentiated support in the use of ICT, the courses based on the participants' profile, the blended learning model, the technological infrastructure within the institutions and the creation of digital competence within the Framework of Teaching Performance. The results provide support to provide guidance to create the required digital training for teachers. Future research should evaluate digital teacher training policies, as well as the role of the school leaders in the implementation of ICT.

Keywords-- Teacher training, structural analysis, ICT, strategic planning.

I. Introduction

Digital competence is defined as the creative, critical, and safe use of Information and Communication Technologies (ICT) [1]. Worldwide, several institutions have designed different frameworks for improving teachers' digital competence such as DigComp 2.0 project, the UNESCO, the ISTE standards for educators, the Critical Digital Literacy, the Teacher Education Information Literacy, ProFuturo, among others [2] [3]. Those frameworks establish adequate levels of progression within an orienting guide for the development of teachers' digital competence. Moreover, they provide methods to engage, observe, measure, and improve the quality of teaching and learning [4] [5]. Figure 1 shows the comparison of skills framework attributes.

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	DigCompEdu	ProFuturo	UNESCO	TEACH/COACH	DEEP LEARNING
Primary audience	Educators in formal and informal contexts	Educators	Teacher-trainers, PD & support personnel, ed. experts, policy-makers	Teachers, Pedagogical/ school leaders, policymakers	Teachers, Schools, Districts, Systems
Core emphasis	Digital competence to enhance and innovate education and training	Digital Pedagogical Competencefor continuous PD	Digital Competence and Use of ICT in Ed. for teacher training	Actionable guidance for quality classroom teaching practices	Pedagogical & Innovative practices to foster deep learning and build capacity
Grades focus	All levels Lifelong learning	All levels Lifelong learning	All levels Lifelong learning	Primary, Secondary, ECI	All levels
Learning progression	✓	✓	✓	✓	✓
Adaptable	✓	✓	✓	✓	✓
Supplement for remote	✗	✓	In partnership with ProFuturo	In progress	✓

Fig. 1 Comparison of skills framework attributes.

Digital learning requires teachers to develop their technical skills and an appropriate pedagogical approach into their own teaching and learning [6] [7] [8]. However, in the Framework for Good Teaching Performance, which is the basic document of the Peruvian teaching profession, the ICT integration is limited to learning sessions [9]. Peruvian public teachers can't evaluate their own digital competence with concrete standards because that competence doesn't exist in the framework mentioned above. This setting leads teachers to use ICT mostly to support standard teacher-centered learning activities [10] [11] such as supporting oral presentation or showing examples of products to be made by students [12] [7]. For effective teaching with ICT, teachers should learn to reason explicitly about how ICT can support specific pedagogical strategies (activating learning, classroom management, dealing with diversity, fostering learning strategies) [7] and create collaborative settings between teachers and students [10] [11].

During Covid 19 pandemic, most teachers required support, guidance, and training on digital pedagogical and assessment skills to reach out learning outcomes and differentiated learning strategies [13]. In 2020, the Closing Digital Divide strategy revealed that 81% of Peruvian public teachers required training to integrate technologies into their pedagogical practice [23]. Additionally, a 2020 study conducted in Chile, Ecuador, Mexico, and Peru found that 39% of teachers were only able to execute basic tasks; 40%, to perform them and use the Internet to browse or send email, and only 13% could do more complex tasks [13]. This data is more acute in teachers who did not receive digital training courses in their initial stage and in their professional development [14]. Within this group there are 42% primary school teachers, who have an average age of 46 [15].

Several efforts have been made during Covid 19 pandemic to improve ICT skills in Peruvian teachers. In 2020, 67% of public teachers out of a representative sample of 28217 accessed ICT training courses. Of these, 92.1% considered that the courses were useful for their pedagogical work [16]. Additionally, in 2021, the Technological Innovation Management obtained a budget allocation of S/ 8 048 712.00 soles (more than USD 2 millions) thanks to the Closing Digital Divide strategy and Development of Digital Schools. This allowed an increase in the number of training programs within the PeruEduca portal [17]. Despite these efforts, ICT training tends to focus primarily on basic technological skills and is limited to a few days [13]. Sometimes it can use traditional methodologies such as hearing about some theoretical knowledge instead of developing practical skills of using digital educational resources [18]. Also, ICT virtual courses tend to have low participants' interactivity and completion rate that is not evaluated by designers, facilitators, and evaluators [19] [20] [21].

Teachers with poor digital educational resources skills spend more time looking for or creating teaching materials during their curriculum development process, which seriously hinders their progress and efficiency [18]. Primary teachers are the ones who spend more time doing this since they didn't receive digital training courses in their pre-service teaching [14]. Also, they are not subject-matter specialists [7] and tend to have an average age of 46 [15]. Researchers have shown that teachers over the age of 50 tend to be reluctant to use technology for learning and seem to be passive Internet users [22]. Little attention has been paid to what is needed to improve primary teacher digital pedagogical skills. From this emerges the need to determine the key factors that will drive the development of digital training programs for public elementary school teachers

II. Methodology

The methodological approach of the study was qualitative with a descriptive scope and a non-experimental design based on an interpretive paradigm. For the present study, structural analysis, a technique of French strategic foresight, was used to identify the key factors of a study system and their interrelation with other factors [23] [24]. This technique studies complex systems such as organizations, sectors, markets, products or territories [25]. It also follows a systematic and participatory process that assumes the perspective of the participants and recognizes the meanings they attribute to a particular phenomenon [23] [24]. In this way, visions for the future are constructed in the medium and long term in order to make appropriate decisions from the present [25].

At the beginning of the research, semi-structured interviews were conducted with 6 experts in educational innovation, project management, digital learning and software development. This contributed to the definition of the 14 factors of the study system. These factors were entered into the Cross-Impact Matrix Multiplication Applied to Classification (MICMAC). This matrix is a tool used to define the contextual relationships between certain elements that represent the key factors of a system [26]. Once this step was completed, the level of influence and dependence of the 14 factors of the study system was evaluated based on the consensus of 9 experts. This made it possible to find the associations of motricity and dependence in order to identify the key factors of the digital training system of public primary school teachers in the Peruvian context.

III. Results

Based on the results at MICMAC, a system with a certain degree of instability was determined. This is characterized by presenting a set of points around the main diagonal, which contributes to high influence and dependence on these factors simultaneously. This generates that any action on a factor has repercussions on the set of others and returns on itself [28]. Next, Figure 2 presents the Cartesian plane with the projection of the 14 factors studied for the system, considering the indirect relationships between them.

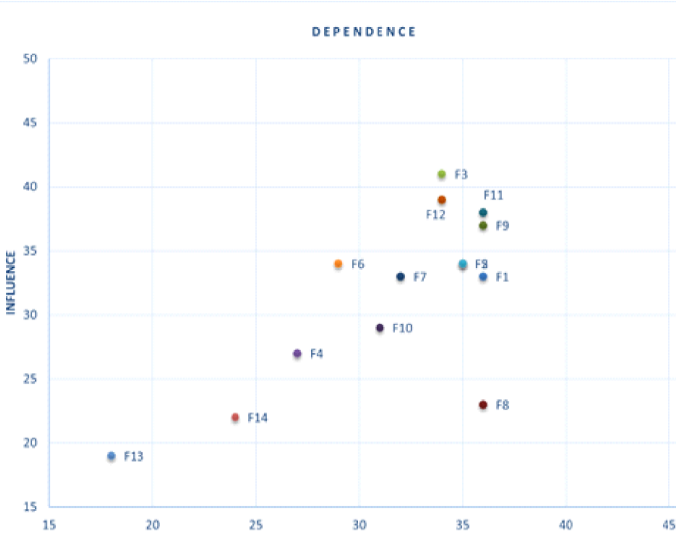

Fig. 2 Matrix of influence and dependence between the factors' system.

The factors located in each quadrant of the Cartesian plane are described below:

Key factors

These are in the upper right zone of the Cartesian plane and have a high influence and dependence. Also, they have an unstable nature and determine the functioning of the study system [26]. Five factors were found in this power zone:

differentiated support in the use of ICT (F9), courses according to the profile of the participants (F3), blended learning model (F1), technological infrastructure within the institutions (F5) and creation of digital competence within the Good Teaching Performance Framework (F11).

Input factors
These are in the upper left area of the graph and are characterized by being more influential than dependent. They act as promoters or inhibitors of the study system [29]. In this quadrant was placed: management leadership in educational institutions (F6).

Regulatory factors
These are located close to the line and their level of influence or dependence is not sufficient to determine the role they play within the study system [28]. Four factors were found in this area: progressive methodological strategies (F2), financing of digital training programs according to the needs of the regions (F12), strategic alliances with stakeholders (F7) and spaces for reflection and collaboration (F10).

Resulting factors
These are found in the lower right area of the graphic and can only be explained by the impact coming from the key and input factors [29]. Only one factor was found in this area: teachers' self-perception of the level of development of their digital competence (F8).

Excluded factors
These have low mobility and dependence and are related to past trends that are not determinant for the future of the study system [28]. Three factors were in this area: decentralized articulation between specialized MINEDU instances (F14), distribution of the hourly load for training courses (F4) and school composition (F13).

IV. Discussion

The digital training of public primary school teachers is characterized as a relatively unstable system [29]. Based on the results obtained, it was found that differentiated instruction in the use of ICT (F9) was the key factor in this system. Teachers who have undergone an ICT training program claim positive effects when trainers adapt the program to their personal development needs, reinforce a subject content taught by them, introduce different activities into learning and focus on innovative teaching practice [30] [31]. Moreover, grouping teachers according to their technological capability, pedagogical expertise and prior knowledge has also shown positive effects in ICT courses [32] [33]. In order to fulfill training goals, designers should gather data about generational group learning and do a previous diagnostic skills assessment [34]. This assessment can help them identify areas of teacher support and develop content for professional development [5]. By this way, designers can design courses according to the profile of primary school teachers (F3) which is the second key factor of this study.

Although spaces for reflection and collaboration (F10) is a questionable factor, constant feedback, participation in collaborative learning, microteaching, expert support, and learning through online professional networks can respond to teachers' diversity especially in terms of their educational background [35] [34] [31]. Also, those spaces can model best practices such as demonstration lessons delivered by experts or pedagogical leaders, examples of interactive practices, or observations of peers [36]. Competent technology-user teachers can help their colleagues integrate technology while considering lesson content and pedagogical approaches. However, not all of them can help their colleagues reflect on their attitudes about using technology for teaching and learning [22] [37]. Therefore, a culture of mutual learning is required to reduce the resistance of ICT use [38]. This culture has demonstrated to be deeper when school leaders and the teaching staff share an educational vision and leadership [39] [40] [41] [42]. However, in many developing countries like Peru, principals are often neglected to receive either no or little training and support [13]. This is related to our findings because management leadership in educational institutions can promote or inhibit the studied system (F6).

School leaders can display a proactive attitude to obtain extra sources of financing by participating in projects related to the provision of equipment for schools [38]. They also can foster inter school collaboration with remote co-workers in the digital workplace, as well as positive relations with the local community to make modern learning environments [43]. This research findings shows that strategic alliances with stakeholders (F7) is not sufficient to determine the role they play within the study system; however, it can be an action fostered by principals' leadership.

Another finding is that self-perception of Peruvian public teachers on their level of development of digital competence (F8) can only be explained by the impact coming from the creation of digital competence within the Good Teacher Performance Framework (F11). In order to fulfil that, the most important Peruvian agencies in the digital area: the Technological Innovation Management in Education and the In-Service Teacher Training Management must set up a digital competence framework that allows teachers to measure and improve the quality of their own teaching and learning based on concrete standards [5]. This orienting guide will promote the design and implementation of teacher training, evaluation, and development policies at the national level [4] [9]. Moreover, the teachers' self-perception of their digital competence can also be explained by the impact coming from the educational leadership. Since the ICT training programs by themself and their teachers' beliefs, competence and perceived usefulness

don't necessarily lead to more collaborative teaching practices [6] [30] [44]. Educational leadership is required to support student-centered pedagogical strategies (activating learning, classroom management, dealing with diversity, fostering learning strategies) [7] [10] [38].

Blended learning model (F1) has shown to be another key factor of the digital training system. Nowadays, many schools in high and low resource settings plan to offer blended and remote learning options for teacher's training [5]. Blended learning combines both face to face teaching and distance using digital technology (synchronous and asynchronous) supported by specific e-learning platforms and tools [5] [45]. In the exams for the certification of knowledge and skills acquired in a blended learning course, Primary School teachers got 10 percent units higher than the one of the traditional model trainees. They also performed better in the essay part and in the educational scenario which was an activity utilizing ICT [45]. Blended programs should guarantee people met in-person at least the beginning and at the end of training. Also, they must regularly check in their students' progress with the program facilitators and with other teachers, using synchronous (videoconferencing) and asynchronous remote communication tools [46] [47]. Also, it can provide multisensory materials to teachers such as videos recorded by experts, interactive multimedia resources, classroom materials, video tutorials, guided exercises, forums, external links, self-correcting questionnaires, and resource creation workshops [19] [18]. Moreover, it's essential to establish clear milestones with abundant open-ended exploration. Figure 3 shows a visual representation model for Blended learning designs.

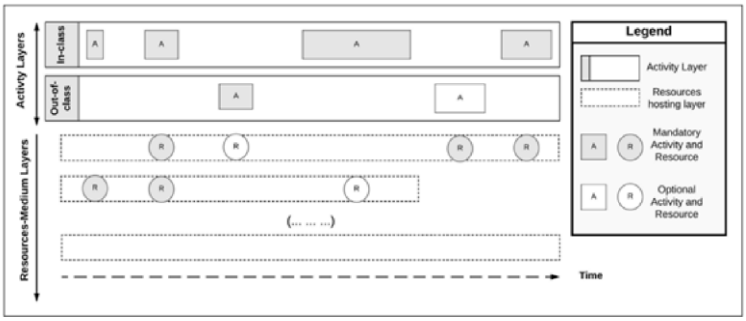

Fig. 3 Visual representation model for BL designs.

Finally, the current technology gap is not measured in terms of infrastructure, but rather in the percentage of teachers who are able to discriminate and regulate its use according to the context and needs of their students [48]. Furthermore, it is teachers' pedagogical strategies for teaching and learning that leads to the use of ICT, not the ICT devices themselves [7]. Despite these studies, the limited accessibility, network connectivity and inadequate technical support are important obstacles faced by teachers when adopting ICT tools [37] [13]. This is the case of Peruvian public schools in which only 5% of them have Internet access [17]. The effort made by public and private sectors during Covid-19 pandemic to recharging plans and providing cards for mobile data access still needs to ensure connectivity in remote areas [3]. That data reinforces technological infrastructure within the institutions (F5) as a key factor in this system.

V. Conclusions

The structural analysis carried out in the research allowed us to characterize the digital training programs for public primary school teachers. The factors that were key to promoting their growth and development in Peru were: differentiated support in the use of ICT, courses based on the profile of the participants, blended learning, technological infrastructure, and the creation of digital competence within the Teacher Performance Framework. The first three factors require instructional designers to conduct a prior diagnosis of participants' needs and opportunities. The fourth and fifth factors, on the other hand, require the intervention of Ministry of Education agencies such as the Technological Innovation Management in Education and the In-Service Teacher Training Management. These areas are responsible for establishing the criteria and standards of digital competence in an objective and progressive manner within the Framework for Good Teaching Performance.

School administration by itself does not have a major impact on the system studied. However, when it is interrelated to the transformational leadership of the headmasters, it becomes a disseminator of a collaborative and innovative ICT culture that benefits the teaching staff and establishes possible connections with external allies. The factor spaces for reflection and collaboration, contrary to what was obtained in the MICMAC, does represent a necessary element within teacher professional development programs. As long as its use is disseminated through instructional designers and managers.

The lines of research that arise from the results obtained are linked to the establishment of a framework that fits the vision and diagnosis of the digital pedagogical skills of Peruvian public teachers by the Directorate of Technological Innovation in Education and the Directorate of In-Service Teacher Training. Also, new studies could investigate how the leadership of school principals fosters a collaborative culture of ICT integration in vulnerable contexts. The identification of the key factors in the system studied lays the foundation for creating a strategic plan to guide instructional designers and managers in improving digital teacher training programs in terms of time, resources, participant profile, evaluation, student-centered learning activities, among others.

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