Digital competencies in teachers and students during the pandemic: a systematic review

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Abstract –The pandemic generated by the COVID 19, led to a series of demands at the educational level, especially those related to the digital competencies of teachers and students necessary for the teaching-learning process. The general objective of this research was to analyze the studies conducted regarding digital competencies in teachers and students during the pandemic through a systematic review. It is a basic, qualitative, phenomenological research, having as method the systematic review under the Prisma approach, using the documentary analysis technique, as well as the individual analysis matrix instrument. The population consisted of 3472 articles from the Scopus database, written in English, Spanish and Portuguese on digital competencies, digital skills or technological competencies during the years 2020 to 2023. Likewise, the total sample consisted of 82 articles and the Rayyan program was used to arrive at it. Among the results, it was found that high school teachers have higher digital competencies, and among them, female teachers have slightly higher digital competencies than male teachers. On the other hand, undergraduate students have better digital competencies. Likewise, as digital competencies favor the learning of students and teachers, that information literacy is associated with digital awareness, and that, although there are trainings for teachers and students, they are insufficient and without a previous diagnosis, since it is necessary to consider levels, previous knowledge and accompaniment. Also, in the use of digital tools, several digital resources are employed, and the use of the Flipped Classroom methodology is scarce. Likewise, it was found that they have difficulties in digital security issues and low content creation. As a corollary of the research, it was mentioned that it is necessary to continue working on these slight differences in the development of digital competencies in relation to gender, both for teachers and students. Also, to elaborate plans for implementation, monitoring and support of technological development, based on a scaling of digital competencies that include both the management of digital resources, as well as the knowledge of the resources and an improvement of attitudes towards technology and information literacy.

Palabras clave: digital competencies, technological competencies, systematic review, Prisma methodologe

I. INTRODUCTION

The COVID 19 pandemic generated a series of changes in education, from face-to-face classes to remote classes, whether in schools, institutes, or universities. This new scenario led to a series of trainings for educational institutions, so that their teachers and students could successfully face this new teaching-learning scenario. At first, the educational institutions had to make a diagnosis to know the state of digital skills of the teachers in charge, and based on this, to know the aspects they needed to then develop a series of training in order to enable them to handle more skillfully, the use of videoconferencing through Zoom and Google Meet, and the pedagogical management of the class, using applications such as Edmodo, Moodle, Google Classroom, Canvas, Nearpod, Mentimeter, to name a few.

In the case of students, the situation was quite similar due to the need to learn new ways of connecting to classes, how to interact with classmates and teachers, how to access resources. All this, around collaborative learning, which allows learning to be understood as an internal and social process [1], and where technology favors collaborative learning [2]. Likewise, the existence of technological and pedagogical supports became necessary, both for teachers and students, so that, in case of any difficulty or doubt, they could have the appropriate guidance and solution.

The above scenario generated that the scientific community began to conduct a series of investigations with the aim of learning about the experiences, challenges, implementations and factors associated with the development of digital competencies [3], [4], [5], [6], [7]. According to the [8, p. 3]. digital competencies facilitate the use of "digital devices, communication applications and networks to access and manage information, create and share digital content, communicate, collaborate and solve problems for effective and creative self-fulfillment, learning, work and social activities in general".

Considering theabove, information and communication technologies (ICT) constitute a transversal axis in the training of people in the different fields of their lives, whether in everyday, social or professional life. In addition, the institutions that provide formal education, such as schools and universities, are a strategic location to develop digital competencies because in their classrooms are teachers who

have the responsibility to mediate and enhance the learning of their students in the classroom.

The above could be seen as an expected, desired and recommended situation that would have successfully faced the sudden change generated by the pandemic, from face-to-face to remote classes. However, the local, regional and international reality had several variants, some of them being the *age and gender of teachers and students, attitudes towards technology, the level of literacy and information, the information they receive from the training, the use of digital tools, and the creation of content and security.*

In a study of higher education teachers in Spain found that there are few significant differences in the digital competencies of both sexes, especially in digital competencies, digital ethics, ICT anxiety, quality of ICT resources, and their intention to use them [9]. Also, in Spain, in an investigation of teachers in vocational training showed a high perception in all digital competencies in eight areas of competencies (five digital and three socio-professional competencies for digitality), with gaps depending on the age of the participating teachers [10].

Likewise, in German Internet users, reported that digital skills and personal innovativeness in predicting deepfake knowledge, and that while age plays only a minor role, female gender is strongly related to low knowledge and negative attitudes towards deepfakes [11].

On the other hand, an important topic is the *attitudes towards technology*, which go from the fact of incorporating them to change, interest, curiosity, being aware of their benefits and having a resilient attitude towards challenges, leading to their use in the classroom. In this regard, in research on the educational action of children in Turkey during the pandemic found that teachers had to adapt their methods during the pandemic [12], thus evidencing the use of technological resources. Likewise, in research with educators in training and former students found that they were accustomed to using technology for their academic activities [13]. These aspects are important because they favor young people to develop skills that allow a critical and safe interaction with Internet technologies [14], and to favor the integration of digital badges, as a way to foster interest and motivation in the classroom [15].

Data and information literacy is an aspect to be considered for digital competencies in people. In this regard, in Kazakhstan and Turkey, that better learning is achieved with STEM (Science, Technology, Engineering and Mathematics) methodology through the use of digital resources in students [16]. In research on Indonesian teachers showed that the majority of teachers, whether they are high school or university teachers, are in the exploration and integration phase, the majority of 43% of the integrator levels and 17.2% of the exploration levels, also 26.9% of the expert level and 6.5% of each of the leader and pioneer levels [17].

Similarly, that most students reported having basic digital skills, and that they faced challenges such as information management, research, critical thinking, creativity and innovation [18]. These aspects highlight the need to implement sustained policies to comply with the training of students, accompanied by infrastructure, and that additionally, curricular development should be incorporated, as mentioned by [19]. Likewise, this information literacy process could take place in schools, following the experience in England of [20], who in an investigation of a math test using an iPad showed that gender and test type impact math test scores, with females obtaining the best results on the iPad test.

Now this whirlwind of changes in the information and communication society has demanded a constant motivation and a need to learn about the use of technologies, which has represented a constant training on how to learn them and incorporate them into educational practice, although these processes have not been linear and constant. In this sense, in Spain, [21], as a result of a research on university teachers, revealed the need for initial and ongoing training in digital competencies.

In the same way, refer those secondary and special education teachers should receive continuous and accessible training, something quite similar to what [22], [23], referred to in a research of Chinese nursing teachers, where the need to design personalized digital education programs according to age was seen; considering that there are different levels of education, disciplines and institutional categories [24].

In the same vein, [25] revealed in a study with university teachers in China that ICTs were important for classroom development, and that teacher training should be optimized; that is, it is necessary to translate into institutional documents a training plan, which could simultaneously be framed within digital literacy frameworks [10], [26], with an appropriate training policy.

Now in relation to *digital tools*, in Nepal, [27], in research with college teachers of mathematics evidenced that sharing and integrating digital resources is significantly related to student assessment. Likewise, in Spain, [28], in a study with trainee teachers found that they referred to the need to use educational resources because they promote behavioral and discovery learning, and have an interactive function.

In the same way, the management of digital competencies goes through the fact of creating content, which goes beyond the application of desktop tools or presentations with classic models. In this regard, [25], revealed in a study with university teachers in China that they had a weakness in the creation of content; unlike those found by [13], who, in a study with educators in training and former students, found potential in the creation of content. Now, [21], affirmed that there is a difference in the self-perception of content creation among public university teachers, who have a lower level, as opposed to private universities, where they have higher records.

On the other hand, ethical aspects are necessary for training in digital competencies. On this, in Spain, [29], in a study on education students, states that the preparation of educators with professional and ethical knowledge in training is insufficient, as well as [11], in research on German Internet users, found a generally low level of knowledge and a strong

focus on risks in the perception of deepfakes by Internet users. This may incorporate situations of privacy violations and risks of sensitive information.

Since the issue of digital competencies is a current topic, as it has not yet returned in its entirety to face-to-face classes, it was proposed to conduct an analysis of the most recurrent aspects in the literature, in order to find the prospects that aim to improve the quality of education. Considering the above, it was proposed as a general problem: to analyze the digital competencies of teachers and students of high school and university during the pandemic, a systematic review. Also, the following specific objectives were considered: to know the particularities of the digital competencies of teachers and students in relation to age and gender; to identify the attitudes towards technology of teachers and students; to know the characteristics of data and information literacy; to analyze the need for training, to examine the characteristics of digital tools, to recognize the characteristics of the use of content creation and digital security, all of them of teachers and students of high schools and universities, through a systematic review.

III. METHODOLOGY

The research was basic because it increases the wealth of knowledge [30], with respect to digital competence. The approach is qualitative because it favors the need for interpretation of the phenomenon and because the data are preferably qualitative [31], because the data are descriptive, performing an inductive analysis [32], Likewise, the systematic review was employed, which involves the identification of primary documents, around the research question, the critical evaluation and the synthesis of findings [33], which for our case are the scientific journal articles in the Scopus databases from 2020 to 2023, the time that the pandemic lasted.

The systematic review method will reduce bias in the selection of documents, as well as improve the conclusions drawn [34], Likewise, this will be done with the Prisma methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). This methodology represents a tool to ensure the quality and transparency of the articles [35].

The collection technique used is documentary analysis because it allows describing and representing documents in a unified and systematic way to facilitate their recuperation [36], all this, by going directly to the source [37]. Regarding the sample, it was selected with the following formulas in the search engine: digital skills AND teacher OR student, as well as technological skills OR ability skills; all related to teachers and students of high schools and universities. Then, considering [38], for the selection of articles some inclusion/exclusion criteria were considered, which were established a priori and by the characteristics of the research (see Table 1).

Table 1

Filters used in the Scopus database

Criteria	Specificity
Period of publication	2020-2023
Publication status	Published
Type of publication	Open Access
Languages	English, Spanish and Portuguese
Document types	Scientific articles
Sources of information	Scopus database
Stage of publication	Final

Note. According to [39] *and the needs of our research.*

Considering the above, 3472 articles were selected, leaving 126 in a second review. They were then uploaded to the Rayyan software, where three team members were in charge of reviewing the documents, under the blind on mode, where what was selected by one reviewer was not seen by the other; to subsequently meet and evaluate the articles where there was no agreement, to discuss their content, and by consensus consider whether or not they should be included, with the final result of this process being a total of 99 articles. In this process, research related to digital citizenship, digital monitoring, digital literacy, information competencies, digital tutors, intercultural competencies and ICT use were found.

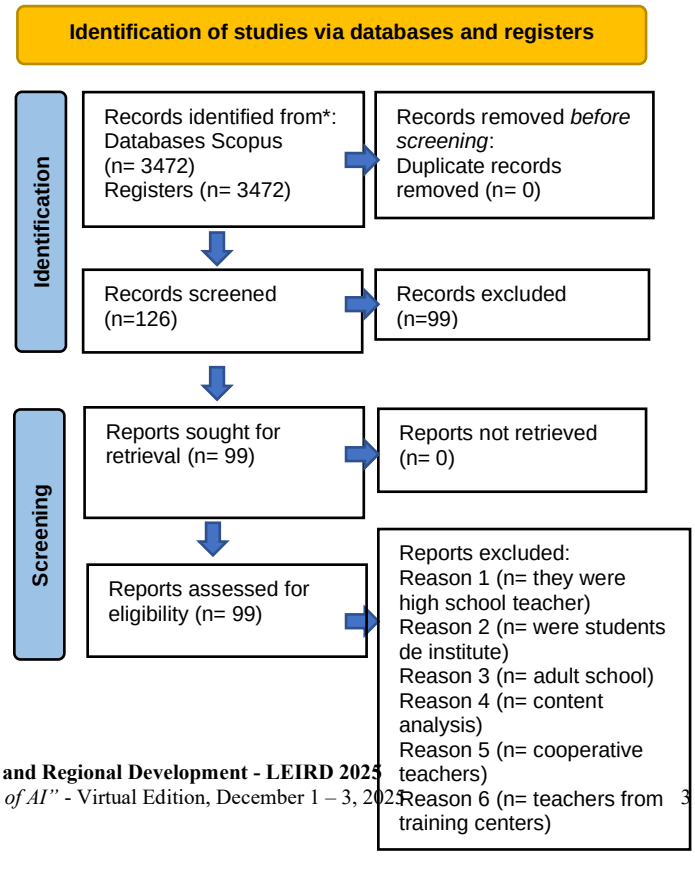
In addition, in a second review, some clarifications were found within the documents, which led to a reduction of articles from 99 to 82. Among the criteria considered for their exclusion were that they were institute teachers and students, belonged to adult schools, were content analysts, were cooperative teachers and were from training centers.

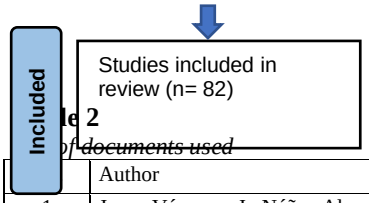
Articles will be considered exclusively for high school and university teachers, as they represent a broader field of study, and similarly for students

The above processes can be visualized in and Figure 1 y Tables 2

Figure 1

Study identification Prisma diagram





le 2

of documents used

	Author
1	Jorge-Vázquez, J., Náñez Alonso, S. L., Fierro Saltos, W. R., & Pacheco Mendoza, S.
2	Estrada-Molina, O., Guerrero-Proenza, R. S., & Fuentes-Cancell, D. R.
3	Herrera, A., Huaire, E., Mori, M., Condori, P.
4	Grande-de-Prado, M., Cañón-Rodríguez, R., García-Martín, S., Cantón-Mayo, I.
5	Franzoni, A., Cardenas, M., Manudajo, J.
6	Cáceres-Rodríguez, C, Mª Ceballos, E., Torrado, E.
7	González, I., Cebreiro, B., y Casal, L.
8	Ordóñez Olmedo, E., Vázquez-Cano, E., Arias-Sánchez, S., y López-Meneses, E.
9	Navarro-Medina, E., Pérez-Rodríguez, N. y de Alba-Fernández, N
10	López Díaz, E.K., Lizcano Reyes, R.N.
11	Demeshkant, N.
12	Nguyen, K. P., Luke, A. K., Cheng, Y., John, A., y Cham, K. M.
13	Sandí-Delgado, J. C., Sanz, C. V., y Lovos, E. N.
14	Salem, M.A.; Alsyed, W.H.;Elshaer, I.A
15	Valverde-Crespo D., Pro-Bueno A., González-Sánchez J.
16	Castillo Rojas, S. V., Sánchez Xicotencatl, C. O., Castro Thompson, A., y Escalona Ríos
17	Luz F, Fonseca M, Franco D
18	George-Reyes C, Glasserman-Morales L
19	Acuña-Gamboa, L., Mérida-Martínez, Y., & Pons-Bonals, L.
20	Mukherjee, M., Nykvist, S., y Blundell, C.
21	Nikou, S., y Aavakare, M.
22	Nguyen, T.
23	Sánchez, A., Woo, R. M., Salas, R. C., López, F., Narvaez, E. G., Lagune A., y Torres, C. A.
24	León, F., Ramírez, M., Díaz, A., y Guzmán, T.
25	Perifanou, M., Tzafilkou, K., y Economides, A.
26	Rodríguez-Jiménez, F., Pérez-Ochoa, M., Ulloa-Guerra, Ó.
27	Marrero-Galván, J., Medina, M.
28	Araújo, A., Carvalho, M., Ovens, A. y Knijnik, J.
29	Concepción, J., López-Meneses, E., Vásquez-Cano, E., Crespo-Ramos, S
30	Marin, A. y Chitimiea, A.
31	Casillas-Martín, S., Cabezas-González, M., García-Valcárcel, A. y Basilotta-Gómez-Pablos, V.
32	Vásquez, M., Roig-Vila, R. y Peñafiel, M.
33	Fernández, M., y Jurado, A.
34	Reis, A., Leite, C.
35	Cham, K. M., Edwards, M. L., Kruesi, L., Celeste, T., & Hennessey, T.
36	Aznar, I., Cáceres, M.P. y Romero-Rodríguez, J.M.
37	Romero-Tena, R., Llorente-Cejudo, C., Puig-Gutiérrez, M., y Barragán-Sánchez, R.
38	Jaimes, P., Pérez, L., Celis, O., y Ramírez, L.
39	Antón-Sancho, Á., Vergara, D., y Fernández-Arias, P.
40	Crawford-Visbal, J., Crawford-Tirado, L., Ortiz-Záccaro, Z., y Abalo, F.
41	López-Belmonte, J., Moreno-Guerrero, A., Pozo-Sánchez, S., y López-Núñez, J.
42	Oliva-Cruz, Eduardo, y Mata-Puente, A.
43	Yanuarto, W. N., Hapsari, I., y Suanto, E.
44	Tomczyk, Ł.
45	Rodrigues, A., Cerdeira, L., Machado-Taylor, M. y Alves, H.
46	Portillo, J., Garay, U., Tejada, E. y Bilbao, N.
47	Pérez-Escoda, A., Lena-Acebo, F. y García-Ruiz, R.
48	Parra, D.
49	Lebid, A., Krasulia, A., Sushkova, O. y Shevchenko, N.
50	Moreno-Guerrero, A., Miaja-Chippirraz, N., Bueno-Pedrero, A. y Borrego-Otero, L.
51	Cifuentes, L. y Crespo, M.
52	Liesa-Orús, M., Latorre-Cosculluela, C., Vázquez-Toledo, S., Sierra-Sánchez, V.
53	Escobar-Zúñiga, J., Arenas-Martínez, E. y Sánchez-Valencia, P.
54	Bernate, J., y Fonseca, I.
55	Holguin-Alvarez, J., Apaza-Quispe, J., Ruiz, J. M., y Picoy Gonzales, J.
56	Lin, R., Chu, J., Yang, L. et al.
57	Hämäläinen, R., Nissinen, K., Mannonen, J., Lämsä, J., Leino, K., y Taajamo, M
58	Saikkonen, L. y Kaarakainen, M.
59	Budai, B.B.; Csuhai, S. y Tózsa, I.
60	Dias-Trindade, S., Moreira, J. A., y Ferreira, A. G.
61	Moreira, J.A.; Nunes, C.S. y Casanova, D
62	Pozo, S., López , ,J., Moreno ,A.J. Y Hinojo-Lucena, F. J.
63	Ruiz-Cabezas, A., Medina-Domínguez, M. C., Subía-Álava, A. B., y Delgado-Salazar, J. L.
64	Urbanek, A.; Losa, A.;Wieczorek-Kosmala, M.; Hlavá˘cek,K.; Lokaj, A
65	Rawat, S., Tiwari, S., Sharma, M., Singh, N.C.
66	Joshi, D. R., Adhikari, K. P., Khanal, J., & Belbase, S.
67	Rioseco Pais, M.; Silva Quiroz, J.; Carrasco-Manríquez, C.
68	Lin, R., Chu J., Yang, L., Lou, L., Yu, H., Yang, J
69	Madsen, S.S.; O'Connor, J.; Janeš, A.; Klan˘car, A.; Brito, R.; Demeshkant, N.; Konca, A.S.; Krasin, S.; Saure, H.I.; Gjesdal, B.; et al.
70	Tirado-Morueta, R., García-Ruíz R., Hernando-Gómez A., Contreras-Pulido P., Aguaded-Gómez, J.
71	Flerlage, C., Bernholt, A. y Parchmann, I.
72	Vera, F. y García-Martínez, S.
73	Mogas, J.; Cea Álvarez,A.M.; Pazos-Justo, C.
74	Roll, M. y Ifenthaler, D.
75	Youssef, A.; Dahmani, M.; Ragni, L.
76	Sarva, E.; Lama, G.; Olesika, A.; Daniela, L.; Rubene, Z.
77	Hajduová, Z., Smolag, K., Szajt, M. y Bednárová, L.
78	Basantes-Andrade, A., Cabezas-González, M., Casillas-Martín, S., Naranjo-Toro, M. y Benavides-Piedra, A.
79	Kryukova, N. I., Chistyakov, A. A., Shulga, T. I., Omarova, L. B., Tkachenko, T. V., Malakhovsky, A. K., y Babieva, N. S.
80	Hampton, K. N., Robertson, C. T., Fernandez, L., Shin, I., y Bauer, J. M.
81	Stare, J., Klun, M. y Dečman, M.
82	Qerimi, G., Jahiri, M. Ujkani, B. y Zeneli, A.

Then, these documents were uploaded to the Atlas ti Version 25 program, where the assignment of codes began, and the rootedness and density among them was recorded, to then consider the creation of groups of codes, according to the categories proposed: *age and gender*, *digital competencies favor learning*, *attitudes towards technology*, *training*, *digital tools*, *content creation and security and social networks.* Subsequently, networking was performed, and the predominance of the information was established to consider the wording of the results.

IV. RESULTS

With regard to the results, at the beginning there is a predominance of Spain with 28 documents, followed by Mexico and Colombia with seven documents each, and

Portugal with five. In addition, Australia, Poland, Finland, Ecuador with three documents, China, Germany, Venezuela and the United States with two. And now, Chile, Brazil, Argentina, Saudi Arabia, Vietnam, Russia, Romania, Republic of Kosovo, Puerto Rico, Peru, Norway, Nepal, Latvia, Indonesia, India, Hungary, Greece, France, Slovenia, Cuba, Costa Rica, with one document each.

In relation to age and gender, it has been found that high school teachers have higher digital competencies in terms of the application of these in the educational field. Now in the case of age, high school teachers have slightly higher digital competencies than other teachers. Regarding the gender difference in undergraduate students, it is observed that males have better digital competencies. Likewise, they report that among teachers and undergraduate students there are no differences between gender and age. There are varied digital competencies among undergraduate students (male and female).

One of the aspects found was that digital competencies favor the learning of university students, and that the increase of digital awareness in undergraduate students favors their learning. Also, female teachers have higher digital competencies.

Likewise, it was found that *attitudes towards technology* should motivate school teachers to use technology in the development of their classes. Also, school teachers should improve data literacy and digital competencies at the level of rural school teachers. There is a need to integrate artificial intelligence into the professional training of high school teachers.

At university level, undergraduate students have a low level of data and information literacy, and there is a need to integrate digital skills into citizenship. There is a need to integrate digital competencies in the training of undergraduate students and increase their awareness of the digitization of society. Another aspect observed was that the digital competencies of teachers are related to the digital competencies of students.

With regard to *training*, there is a need for a training plan for high school teachers that takes into account contextual, personal and programmatic factors. Likewise, there is a need to integrate artificial intelligence in the professional training of school teachers, and there is also a need to reverse the digital infrastructure of educational institutions.

In the case of the university, university professors have the need to improve digital competencies and soft skills (professors perceive that they have a low level of soft skills) as well as to improve the creation of content and tools by area. Also, improvement plans should be developed that include the incorporation of improvement of digital competencies for new teachers at the university. Within the trainings, the need to integrate digital competencies to the undergraduate students is raised. Also, these students have a low level of data and information literacy.

In terms of *digital tools*, high school teachers use tools such as WhatsApp, Google Classroom and Zoom for their classes; in addition, high school teachers have limited digital competencies and do not use the Flipped Classroom methodology. Moreover, there is a relationship between the digital competencies and the resources available to high school teachers.

In the case of the university, teachers develop the creation of content and tools by area, although they have difficulties in digital security issues. And on the side of graduate students, they show digital competencies to evaluate educational resources. In the case of the use of social networks, there is little use of social networks for academic purposes, finding the experience of X to develop digital competencies in schoolchildren.

IV. Discussion

In relation to age and gender, it has been found that female high school teachers have higher digital competencies and that they are applied in the educational field. Regarding the gender difference in undergraduate students, the results report that males have better digital competencies. Also, that among teachers and undergraduate students there are no differences between gender and age; coinciding with what was mentioned by and opposite to what the result of the research reports when referring that there are varied digital competencies among undergraduate students, and that female university students have higher digital competencies [40].

Also, women have lower levels of knowledge about the Internet than men, and that university students fail to understand the diversity of uses of the Internet [41]. Likewise, one of the aspects found was that digital competencies favor the learning of university students, and that the increase of digital awareness in undergraduate students favors their learning as well. Additionally, female teachers have more digital competencies.

While age and gender are not areas of the Dig Comp, they are sociodemographic aspects that can help understand the differences between the people in the sample.

Now, regarding *attitudes towards technology*, it was found that high school teachers should be motivated to use technology in the development of their classes, that a necessary aspect is to optimize their data literacy and digital competencies at the level of rural high school teachers. One aspect that can be linked to the above is that college teachers spend more time on the computer, above the cell phone, and internet connection [42], and that although it could reveal a positive attitude towards technology, it would be necessary which activities they perform, that is, if they are basic or advanced competencies. It is worth mentioning that these attitudes towards technology reveal that teachers are partly responsible for creating meaningful environments to deepen students' learning experiences and enhance capabilities [43].

Regarding the Dig Comp, it is specified that digital skills that promote learning are framed within area 2: communication and collaboration, and area 5: problem solving.

Also, it was found as a result that there is a need to integrate artificial intelligence into the professional training of high school teachers. The way educators teach has been drastically influenced by artificial intelligence (AI) to improve learning outcomes, student achievement and attitudes in a post-pandemic world. It is necessary to consider that attitudes towards technology are progressive and continuous in people, as new tools are integrated every day [44]; where the place of access comes to influence the intensity and types of technology use [45].

Regarding *data and information literacy*, it was found that, at the university level, undergraduate students possess a low level of it, being necessary to integrate digital competencies to the population. There is a need to integrate digital competencies in the aspects of undergraduate students, increase of digital awareness in undergraduate students, of digitalization of society. Another aspect that was found was that teachers' digital competencies are related to students' digital competencies, associating that these dimensions of information literacy and digital literacy play interconnected roles in the development of people in the digital era.

When they state that digital literacy is important because it allows citizens to participate in digital activities, and that at present, they represent a trend for most professionals in the near future [44]. Similarly, the study [46] states that 21st century learners need to master information literacy and critical thinking skills to succeed in learning advancement.

Similarly, that ICTs have generated the need to promote the use of digital skills for employment and for society [47], and that workplaces require skilled workers [48]; that is, they are seeking to receive professionals with digital skills capable of addressing the technological needs of the enterprise. In the same vein, in addition to appropriate technological education, both teachers and students should be trained and develop digital competencies [49], and both should generate continuous learning synergies. Likewise, the development of digital competencies is fundamental for university students to be able to perform at a professional and academic level both in the educational and professional use of digital technologies [50].

Now, we believe that school education plays an important role as it is the first formal step in technological education, to which points out the need to integrate digital competencies into the school curriculum [51]. We also specify that this should continue during university life, because it should not be assumed that university students are equipped with digital skills, because as [52] refer, when students who lack digital skills and knowledge are found, they will have difficulties to cope with technology-enabled learning.

In this sense, the work of the educational institution and teachers should consider the changes in the environment and the diversity of teaching - learning resources, [53] the formation of technological competencies should occur during university life, and it could be integrated into a basic curriculum and not assume that a student arrives at university digitally equipped [40]. In relation to the results found, *training* was recurrent, especially in relation to the training plan for high school teachers that includes the framework of contextual, personal and programmatic factors. Likewise, there is a need to integrate artificial intelligence in the professional training of high school teachers, and it is also necessary to reverse the digital infrastructure of educational institutions.

It was also found that at the level of university teachers, there is a need to improve digital competencies and soft skills (teachers perceive that they have a low level of soft skills) as well as to improve the creation of content and tools by area. Likewise, it should develop improvement plans that include the incorporation of digital competencies for new teachers. Within the trainings, the need to integrate digital competencies to undergraduate students is raised. Also, these students have a low level of data and information literacy.

Considering the above, it is necessary to consider the incorporation of artificial intelligence as a digital competence for both teachers and students. In that sense, teachers should be trained to be able to use and teach artificial intelligence in their teaching environments [43] because it also allows them to be connected with their students, with their colleagues and properly with the advancement of technology [51]. In the same sense, the use of AI tools allows connecting kno1wledge with the quality of teaching and classroom management, so that AI competencies become a transcendent and useful technological skill for this 21st century [43].

In the same logic, [54] refer that in this context, continuing digital education is important to enable people to adapt and thrive in a world increasingly driven by technology. We believe that these trainings are those that should consider the level of access (places and access devices) and their level of inclusion (uses and skills), need to understand [45] Regarding *digital tools*, the results report that high school teachers use tools such as WhatsApp, Google Classroom and Zoom for their classes; also, that high school teachers have limited digital competencies, and that they do not use the Flipped Classroom methodology. The little or no use of this methodology causes the loss of a progressive connection to the class, to the development of information literacy and critical thinking [46]. It becomes necessary for students to have a first approach with the subjects of the class, to gradually change the paradigm of starting without more than previous learning, and to promote that it is student-centered.

Now, relating it to the Dig Comp, the areas linked to digital tools are area 3: creation of digital content and area 4: security.

Likewise, the results revealed the existence of a relationship between digital competencies and the resources available to high school teachers. These aspects reaffirm the idea that a teacher should be aware of the changes in their

innovative learning environment, the new teaching-learning methodologies and the diversity of their resources [44]. Additionally, the relevance of analyzing the relationship between physical access, uses and implications of physical access should be considered [45]

These conditions should be contemplated so that the contact with technology is the most appropriate and comfortable for teachers, as well as the establishment of technological tutors who obtain, through datamoments of greater or lesser use of the tools, as well as the most used tools. With this information, information should be sought in order to design a plan for the improvement of teachers' digital competencies. In this sense, it is necessary to carry out a brief diagnosis in order to know what digital tools are used in teaching practice, how they are applied in the teaching-learning process, for what purpose they are used, what hinders their practice, whether a technological support area is needed for teachers, among others.

Now, in relation to the findings on *content creation* and *digital security*, the results revealed that, at the university, teachers develop the creation of content and tools by area, although they have difficulties in digital security issues. This is associated with the digital competences of university students are high, although low for content creation [50]; where it could be inferred that it is related to the capabilities of their teachers in this activity.

Another result found was that graduate students show digital competencies to evaluate educational resources; that is, to identify the veracity and reliability of information sources for professional and personal purposes, as well as for knowledge construction. It can also be affirmed that the development of digital competencies is a key factor for both practicing and novice teachers [55]; as well as understanding that improving the quality of digital competencies of teachers will contribute to improving the quality of competencies in students [56].

Conclusions

It has been found that there are slight differences in the development of digital competencies at the level of high school teachers, where female teachers are the ones who have a higher level, although in undergraduate students, there is no major difference between them, nor with age. These aspects may lead to consider that there is a slight difference in the development of digital competencies, making it necessary to know the situations that generate this, such as access to technology, cultural and social patterns, among others.

A transcendental aspect has been the attitudes of teachers towards technology, which has revealed the need for more information literacy, especially in rural areas. This literacy process should have levels that allow to have a diagnosis and to locate the needs, as well as a progress monitoring, together with a technological and pedagogical support to continue optimizing the development of digital competences.

It is necessary to mention that this could improve teachers' attitudes towards technology, considering that the use of technology is transversal to their educational practice. In the same way, in the case of students, whether at school or university, it is necessary to motivate and raise awareness in the empowerment of digital competencies, that is, that they are a means for a faster, constant and varied learning. In the same way, the inclusion of activities incorporating artificial intelligence is oriented by the fact of knowing the set of applications generated with it, along with how and why to use them, as well as the risks and their ethical side.

It was observed the need to incorporate a constant training plan that includes the knowledge and application of technology to the teaching and learning process. This includes how to use them in their educational activity: in the planning of their classes, in the creation of contents, the incorporation of gamification activities or others to the development of classes, the search for information with a higher degree of reliability and impact on the academic community.

One aspect that should be considered for teachers and students at all educational levels is digital security, which is associated with terms of privacy and data privacy and information of the members of the community. These aspects are those that should have been trained in parallel to the use of technology, and that are often overlooked, believed to be implicit and assumed as already known by users, although they are part of the same process of digital competencies. The implications of not being careful with security go with the fact of being vulnerable to sensitive personal and professional information.

The *recommendations* arrived at in this study are to carry out mixed studies, where questionnaires are applied to determine the level of self-perception of the digital competencies of students and teachers, both at school and university. In addition, the inclusion of practical evaluations or cases or simulations or opinions of third parties that allow an adequate triangulation and obtain a more real and reliable evaluation.

Although this work focuses on pedagogical and technological aspects, it is important to highlight that there are cross-cutting elements of educational quality that directly affect the development of digital competencies in students and teachers. These aspects represent core elements of countries' educational policies and pose a significant challenge for universities and schools. Social differences and internet access are a key aspect, given the existence of a digital divide.

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