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# Technological Gap and Academic Performance in Times of the Covid-19 Pandemic: Systematic Review

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***Abstract* – The existing technological gap in the Covid 19 pandemic stage, shows that relevant aspects in education are sharpening, such as learning methodologies, processes and new technologies, which were of limited development before the year 2020, in such a way, that the objective of the research is to describe the existing technological gap and the academic performance of university students from 2010 to 2021. This article is the result of a systematic review process of authors, focused on the university environment. The findings show that despite the accentuated technological gap that is generated in times of pandemic, the academic performance of students was the same or better, however, connectivity in educational platforms and internet access has been an inconvenience that has been It manifests in a greater proportion according to socioeconomic level and geographical areas, however, the teaching-learning process had favorable and unfavorable fluctuations, leaving a field pending analysis in future research.**

***Keywords* -- Technological gap, academic performance, educational assessment systems, digital gap, higher education**

## I. Introduction

In recent years, the adequacy of technology in the development of courses for universities has confused students in the process of their university education, due to the obligation to assume technology as a tool for academic development [1]. In this way, a digital gap is generated, corresponding to the "technological distance between individuals, families, companies, interest groups, countries and geographical areas, limiting opportunities and access to information, including communication technologies, and use of the Internet for a wide range of activities" [2]. In this sense, the academic performance of students takes different forks, especially in the years 2020 and 2021; then, a dependence on factors that were little considered before and closely linked to technology and the virtual [3] is produced.

Technological gap is the difficulty of accessing the digital, which affects the academic performance of university students. To analyze this problem, it is necessary to describe the causes, which, without a doubt, one of the main ones was facing the 2020 and 2021 pandemic years, which has had an impact on the academic performance of students and which represents a measure of the indicative capacity that they manifest, in an estimative way, what a person has learned as a consequence of an instruction or training process [4].

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The investigation of this student problem is carried out in the interest of describing how it has affected academic performance and student learning evaluations, when technology is not freely available and accessible to all actors within the teaching-learning process. In this sense, participation in evaluation processes fosters the development of evaluative judgment and self-regulation [5]. On the other hand, the academic performance in the years 2020 and 2021, unlike other years, is the result of an accelerated self-regulation, of technological processes incident to the forced, the so-called "new normality" that generates challenges and turns the search to achieve an inclusive and sustainable education over time [6].

Table 1 shows the perception of the groups involved in the teaching-learning process regarding the technological gap:

TABLE I
THE TECHNOLOGICAL GAP PERCEPTIONS OF THE GROUPS INVOLVED

| | Perception upon students | Perception upon teachers | Perception about university |
|---|---|---|---|
| **Academic performance as an evaluation process** | It has been verified that regardless of the learning style that the student has (visual, auditory or kinesthetic), when using tools, it was possible to have greater interest during the development of the learning units, and therefore, the students obtained a better academic performance. in the evaluation of each learning unit. [7] | Any technological tool used by the teacher must be accompanied by a prior context analysis, to select the best strategies to be implemented through a platform, and thus measure the impact on the academic performance of the students who worked with said tools. technologies, potentiating knowledge and strengthening their interaction with technology. [7] | Incorporating technology in the university reveals changes in the training process and increased academic performance, as well as the acquisition of skills and attitudes, which contribute to improving the future of work, and achieving constant innovation within the classroom, since it broadens the environment of learning and diversification of work methods . . [8] . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Academic performance as an effect of the use of technological platforms | It positively affects the formation of skills, as long as they feel motivated in the classroom. [9]<br><br>The few students who connect only from the University have better academic results than those who do so from other places, because the main connection point they have access to is the one provided by this institution and for this reason they connect mainly for academic purposes. and not leisure [10] | At the university level, academic staff constitute a key resource, since the level of performance achieved in their teaching and research activities determines the contribution that the institution makes to society [11]<br><br>Both the studies with positive results and those that indicate that there is no significant influence of ICT on academic performance agree that the most important thing is the way in which technology is being involved in educational processes and the role that the teacher is playing.performing. [12] | The university curriculum must integrate the use of technology, adjust the value of skill development, and optimize response opportunities on platforms, so that students can obtain advanced skill development and improve knowledge through virtuality.[13]<br><br>The infrastructure of universities in developed countries has tools available to the entire community, which falls on sufficient technological equipment even for minorities. [10] | Academic performance as an evaluative effect | Students who show a display of great skill in the use of such devices and platforms. But despite the benefits, caution must be taken since it is generating dependency while information is being collected on the degree of autonomy and responsibility of young people, as well as their critical sense to discriminate the information that reaches them. [18] | Teachers must have knowledge of ICT because they provide opportunities to improve the educational quality that is taught. [18].<br><br>The teacher must understand that technologies are just a 'means' that will not solve all their difficulties and that it is their job to make good use of them by proposing different didactic strategies.[20] | There is a relationship between the use of the Internet and academic performance, a circumstance that could differentiate any study center to be recognized for its digital elements, which will be evaluated through the exercise of university teaching [21] . |
| Academic performance according to ICT | The use of ICT is striking for the student, so introducing it in the classroom should be something positive. However, it is observed that sometimes this is not the case. There are students who tend to misuse ICT. [14]<br><br>Those students who use the Internet to try to pass and not to learn have worse academic performance than the rest [10] | The redefinition of the teacher's role is synonymous with one that is not seen as a transmitter of knowledge, but rather its current function, given the flow of information, should be that of a learning mediator, a guide that contributes to learning not only significant, but of permanent construction for a lifetime. [15]<br><br>The teacher is an ally in the learning process since he has the responsibility of using ICT in teaching, this would allow recognizing a dynamic process in the training of university students. [16] . | Information and communication technologies (ICT) have tried to transfer educational systems in order to improve and change teaching and learning practices [17] | | | | |

The evolution of the technological gap has taken special preponderance in the pandemic years. Most students have access to the necessary resources for learning, but these resources are radically reduced during confinement among the most vulnerable students, which causes substantial differences in learning [22].

In this sense, the present investigation addresses the problem of describing academic performance in the pre-pandemic (2010-2019) and pandemic (2020-2021) times, and how this is affected after the analysis of the existing technological gap.

## II. METHODOLOGY

The methodology applied in this research was a systematic review of the literature, based on the PRISMA ( Preferred reporting of items for Systematic Reviews and Meta - Analysis ), which makes use of a list of 27 criteria for document selection and review, as well as a five-phase flow for the systematic review of existing studies [23]; In this particular case, publications made during the years 2010 to 2021 were reviewed.

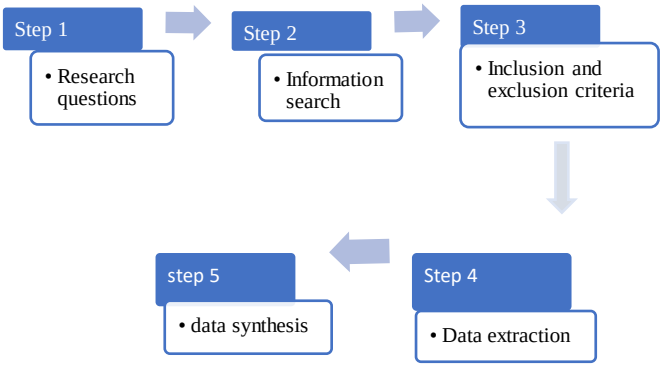


Figure 1. Stages executed for the systematic review process

The research question was raised: How has the technological gap and academic performance evolved during the pre-pandemic and pandemic stage, from 2010 to 2021?

The literature search process was carried out in the Scopus , Proquest , Scielo, Google academic and Web of Science ( WoS ), considering the keywords: academic performance, evaluation systems in education , digital gap, use of technology in students , information technology ; the language (English), the time period (2010-2022) and the type of document (article). The search result was 252 articles, of which 45 were considered potential for the present study (see figure 2).

The inclusion and exclusion criteria of the articles were those with publication prior to the year 2010, that were not from higher education, close to the processes of elaboration, design, and validation of instruments; likewise, that they were from specific fields of knowledge (medicine, biology, physics, etc.) and that they contained a term related to said field of knowledge in the title (except for the field of education or teaching).

Based on the search and analysis of information from documents, the interest in relating academic performance, not from student satisfaction, but rather from a more specific aspect of the use and impact of technological tools, generated a bias with respect to the total information, which represents a limitation for the present work.

For the selection and extraction of data, we sought to systematize information around the following fields: 1) Questions; 2) Objectives; 3) University environment 4) Main contributions of the theoretical framework; 4) Description of experiences and results of academic performance; 5) The technological gap in university students; 6) Management of technological tools before and in pandemic.

Regarding the data synthesis, to synthesize the contributions of each article, we proceeded with a careful reading and the systematization of the main contributions around the determined fields arranged in columns in an online Excel document.

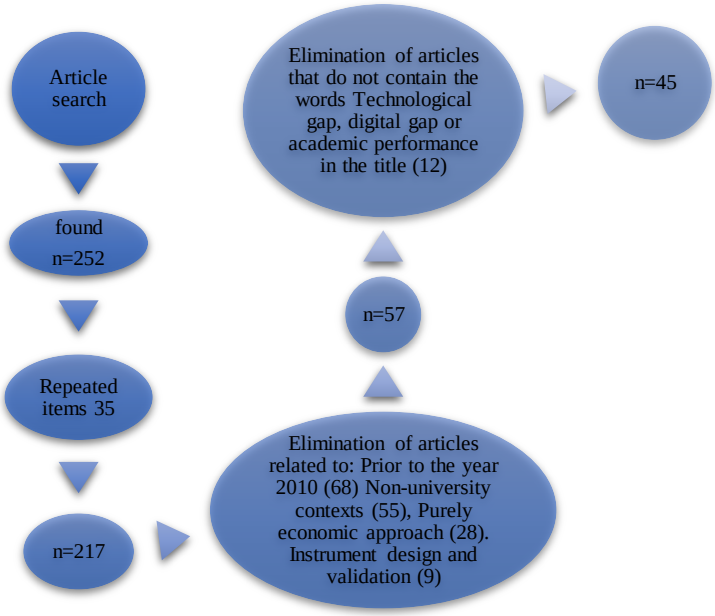


Figure 2Flowchart of the article selection process for the systematic review.

## III. Results

Table 2 shows the 45 articles analyzed for this research; Authors, year of publication, article title, country and database are included: ProQuest Central 19(42%), Scopus 8(18%), Scielo 8(18%), Google Scholar 6(13%) and Eric 4(9%).

Regarding the origin of the selected articles, there is a greater presence of Spanish (32%), Mexican (14%) and Colombian (16%) studies:

TABLE II
DATABASE AND ACADEMIC SEARCH ENGINES OF SELECTED ARTICLES

| . | Author | Title | Country | Database |
|---|---|---|---|---|
| 1 | Nanjundaswam et al. (2021) [31] | Digital pedagogy for sustainable learning | India | ERIC |
| 2 | Gabriel et al. (2012) [32] | The role of digital technologies in learning: Expectations of this year university students – | Canada | ERIC |
| 3 | Narcissus (2021) [33] | Tensions Regarding the Digital Divide in Peruvian Education | Peru | Academic google |
| 4 | Nguyen (2021). [3. 4] | Vietnamese students' acceptance of using video conferencing tools in distance learning in covid-19 pandemic | Vietnam | ERIC |
| 5 | Alhammadi (2021) [35] | The Effect of the COVID-19 Pandemic on Learning Quality and Practices in Higher Education—Using Deep and Surface Approaches | Jordan and Palestine | ERIC |
| 6 | Bercheni & (2021) [36] | The perception of risk and digital gaps in university settings as a determinant of academic performance. Approach from a subject of the Degree in Labor Relations. | Argentina | Academic google |
| 7 | Guzmán et.al (2020) [37] | Digital knowledge of university students from indigenous peoples in Mexico | Mexico | ProQuest Central |
| 8 | Pérez et al.(2021) [38] | Distance education in times of COVID-19: Analysis from the perspective of university students | Spain | ProQuest Central |
| 9 | Chestnut (2010) [10] | Digital inequality among university students in developed countries and its relation to academic performance. | Spain | Scopus |
| 10 | Perez et al. (2021) [39] | Digital gender gap and digital competence among university students | Spain | Scopus |
| 11 | Zabala (2010) [40] | Venezuela: In the digital divide or in the technological revolution? | Venezuela | Scopus |
| 12 | Romero et al. (2021) [41] | Use of mobile devices in higher education: Relationship with academic performance and self-regulation of learning | Spain | Academic google |
| 13 | Leon et al. (2021) [42] | Classroom climate and academic performance: notes on the university context | Ecuador | Scopus |
| 14 | Gamage & Behrend (2022) [43] | A systematic review of trends in the use of Moodle for teaching and learning. | Australia | Scopus |
| 15 | Gomez et al. ( 2018) [24] | The digital divide: a conceptual review and methodological contributions for its study in Mexico | Mexico | heaven |
| 16 | Pedraza et al. ( 2012) [2] | Digital Gap by Socio-Economic Status in the City of Ciudad Bolívar in Bogotá. | Colombia | heaven |
| 17 | Walls (2019) [44] | Gap in the use of basic and modern information and communication technologies (ICT) between students and teachers in Ecuadorian universities | Costa Rica | heaven |
| 18 | Berrio & Rojas (2014) [Four. Five] | The university digital divide: The appropriation of ICT in higher education students in Bogotá (Colombia) | Colombia | ProQuest Central |
| 19 | González et al. ( 2019) [46] | Towards a proposal to measure digital capabilities in internet users | Spain | ProQuest Central |
| 20 | Vega et.al. ( 2008) Baena, L. [47] | Digital inclusion as a development engine. An option for rural Colombia | Colombia | ProQuest Central |
| 21 | Banoy Suárez, W. [48] | The pedagogical use of information and communication technologies (ICT) and its influence on the meaningful learning of technical high school students in Zipaquirá, Colombia | Colombia | ProQuest Central |
| 22 | Fajardo et al. (2020) [49] | Modernization of virtual education and its incidence in the context of Information and Communication Technologies (ICT) | Colombia | ProQuest Central |
| 23 | Santos et al. (2021) [fifty] | Digital technologies and learning ecologies: challenges and opportunities | Spain | ProQuest Central |
| 24 | Giles (2020) [3] | Perceptions and expectations in university students from the adaptation to non-face-to-face teaching motivated by the COVID-19 pandemic | Spain | ProQuest Central |

| | | | | |
|---|---|---|---|---|
| 25 | Sanz (2020). [51] | The effect of the coronavirus on student learning: effect on the use of digital educational resources | Spain | ProQuest Central |
| 26 | Ruiz & Garcia (2020) [52] | Service-learning in digital learning scenarios: an innovative proposal in higher education | Spain | ProQuest Central |
| 27 | Palma et al. (2021) [53] | Technology: impact on the synchronous and asynchronous teaching-learning process of the public universities of Manabí | Ecuador | ProQuest Central |
| 28 | Acuna (2020) [6] | Post-pandemic Higher Education. The asymmetries of the technological gap | Venezuela | ProQuest Central |
| 29 | Lover (2010) [54] | The networked university: a new paradigm of higher education | Mexico | ProQuest Central |
| 30 | Gutierrez (2021) [55] | The digital gap in population at risk of social exclusion | Spain | ProQuest Central |
| 31 | Sales et al. ( 2020) [56] | Perspectives on the informational and digital competence of students and teachers of Social Sciences before and during the confinement by the Covid-19 | Spain | ProQuest Central |
| 32 | Villasol (2021) [25] | Academic performance and patterns of use of the virtual campus: a controlled case study | Portugal | ProQuest Central |
| 33 | Sanz & Lopez (2021) [22] | Pedagogical consequences among basic education students derived from covid-19. a reflection on the great forgotten of the pandemic | Spain | ProQuest Central |
| 3. 4 | Kuric et al (2021) [26] | Education and digital divide in times of COVID-19. Profiles and problems experienced by young students to continue their studies during confinement | Spain | Academic google |
| 35 | Jimenez (2020) [27] | Analysis of technological factors on academic performance in a public university in Mexico City | Mexico | heaven |
| 36 | Fernandez (2015) [28] | Learning approaches in university students and their relationship with academic performance | Cuba | heaven |
| 37 | Kill It (2021) [29] | Digital Capital in Higher Education: Digital Strengths and Deficiencies to Face Distance Education | Chili | Academic google |
| 38 | Miratia (2010) [one] | Effects of the web and ICT on the performance and performance of university students in computing in distance mode | Venezuela | heaven |
| 39 | Flórez et.al (2017) [19] | Knowledge society, ICT and its influence on education. | Colombia | Academic google |
| 40 | Martinez & Heredia (2010) [12] | Educational technology in the classroom: a retrospective study of its impact on the academic performance of university students in the area of Computer Science | Mexico | heaven |
| 41 | coin & Sanchez (2020) [6] | Post-pandemic Higher Education. The asymmetries of the technological gap | Venezuela | Scopus |
| 42 | Oika (2021) [57] | Improving University Faculty Evaluations via multi-view Knowledge Graph | USES | Scopus |
| 43 | Iglesias et.al (2021) [58] | Emergency remote teaching and academic performance of higher education students during the COVID-19 pandemic: a case study | Spain | Scopus |
| 44 | Aguayo et al. ( 2021) [7] | Evaluation of academic performance in virtual environments using the NLP model. | Mexico | heaven |
| 45 | Gomez et.al. (2019) [15] | The role of the teacher to achieve significant learning supported by ICT | Colombia | ProQuest Central |

Table 3 groups topics that lead to a description of the development of the technological gap and academic performance.

TABLE III
TOPICS THAT CONTRIBUTE TO THE DESCRIPTION OF ACADEMIC PERFORMANCE AND TECHNOLOGICAL GAP

| | Issue | Subtopic | Definition of subtopic |
|---|---|---|---|
| **1** | Evaluation [57] | Forms of evaluation | Changes in the forms of evaluation. |
| **2** | Technological development [44] | Use of educational platforms | Use of educational platforms such as Moodle, Classroom, Blackboard, Canvas and others |
| | | access to technology | Use of laptop, pc, tablet or cell phone. |
| **3** | Connectivity [33] [10] | Access to the internet | Internet use and quality |
| **4** | gap incidence _ technological [38] | Incidence of the pre-pandemic technology gap | Affectation of the technological gap in the educational and cognitive aspect from 2010 to 2019. |
| | | Incidence of the technological gap in pandemic | Affectation of the technological gap in the educational and cognitive aspect from 2020 to 2022. |
| **5** | Indicators of success in students. [35] [36] | Student academic performance. | Results of approval or disapproval in the subjects developed. |
| | | virtual classes | Understanding of virtual classes compared to face-to-face ones. |

As shown in Table 3, 5 topics were considered that correspond to specific aspects of the review of the technological gap and academic performance.

Thus Oikan (2021) consider that the evaluative forms have changed considerably, especially in the pandemic years “In many universities, students were asked to complete some questionnaires about the courses at the end of each semester. The questionnaire usually includes a series of questions about the quality factors of the whole class, including options or blank spaces” [57].

It was possible to observe that students mostly use Internet-based technology, without this meaning that they do so for academic purposes; however, teachers take advantage of or give more utility to traditional tools in academic activities such as PCs, projectors and others. We can conclude that in the use of basic technology the gap is small in these two groups, since teachers are in constant training in technology, mainly because HEIs seek continuous improvement in their educational quality [44].

Internet connectivity in Latin American countries was framed within an economic need mainly, "many students did not access, due to ignorance of technological tools and Internet connection, proving educational inequality, mainly in Latin American countries 55% have been affected, where six out of ten homes suffer from this need” [33]. However, access to the Internet alone leads to optimal academic performance "the positive effects of the Internet are greater for those students with a background that already favors, without the intervention of the Internet, obtaining better academic results" [10].

In the pandemic, what stood out was a negative affectation, in the study time of the students, this is due to the inefficient management of technologies by teachers "The virtual classes that they have received have essentially consisted of presentations uploaded to the virtual campus with asynchronous interactions. The negative assessment they make of distance learning is explained by the perceived inverse relationship between dedication to study and academic performance and by the lack of adaptation of teachers to the personal and academic circumstances of the students” [38].

Most of the research papers, during the pandemic years, coincide in better scores in the subjects developed "remarkably, there was an improvement in grades compared to the last online session and the face-to-face learning experience before the COVID-19 pandemic. 19, and there were fewer missing tests and late assignments” [35]. It is not notorious, however, the lack of understanding in the students about the topics developed in virtual environments with respect to the face-to-face ones, except in those themselves affected by the COVID 19 virus, "the students who stated that close relatives have experienced the disease caused by COVID-19 and those who have stated that the pandemic caused them difficulties in learning online” [36].

Table 4 shows the findings on aspects associated with technological gaps and academic performance evaluated in pre-pandemic (2010-2019) and pandemic (2020-2021) times:

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TABLE IV
DESCRIPTION OF EDUCATIONAL ASPECTS IN THE TECHNOLOGICAL GAP AND ACADEMIC PERFORMANCE IN THE PRE-PANDEMIC (2010-2019) AND PANDEMIC (2020-2021).

| Aspects | Gap Technological | Author and Article | Performance academic | Author and Article |
|---|---|---|---|---|
| **Educational and cognitive** | Disparity in economic, educational and cognitive aspects, originated by the possibility of creating opportunities with the use of technologies, for those who know and have them. | Vega & Baena (2008) [47] | Academic performance is the expression of capabilities and psychological characteristics of the student, developed and updated through the teaching-learning process that makes it possible to obtain a level of functioning and academic achievements throughout a period, which are synthesized in a final qualification that evaluate the level reached. | Chadwick, 1979, as cited in Albán Obando and Calero Mieles, 2017 . [59] |
| **Pre pandemic , years 2010 to 2019** | The use of ICT in university teachers was more the product of improvisation than of a conscious and critical process. | Martinez & Heredia (2010) [12] | Previous academic performance constitutes a synthetic variable, in which numerous factors concur (student aptitude, will, effort, characteristics of the teaching received) and which not only reflects the learning result but is an expression, in a certain sense of the whole person of the student as a student | Tejedor, 2003, as cited in Ocaña Fernández, 2011 [60] |
| | Access to digital media is defined as the complete process of appropriation of technology by users. After the year 2000, the importance of digital divides shifted from physical access to skills and use. However, the main media effects of all these divisions are unequal benefits and participation in society. | Gomez Vahos et.al (2019) [15] | | |
| **During the pandemic, years 2020 and 2021** | In students, learning is determined by socioeconomic conditions, geographic location and the type of educational institution to which they belong, offering more opportunities to those who access education from socially favorable positions, with the consequent inequity in education as a deepening social process. not only the socioeconomic and cultural gap, but also the technological gap. | Acuna & Sanchez (2020) [6] | Virtual learning is a social cognitive process, it is not simply a matter of information transmission, the lack of clarity in the instructions by the teachers when requesting the tasks represents an important difficulty in the development of the teaching-learning process, further complicating the precarious socio-emotional situation of the students in the delivery of requested activities and tasks, impacting their grades. | Castillo & Gervacio (2021) [61] |
| | The COVID-19 pandemic forced educational institutions of all academic levels to change learning environments, the main drawback in most institutions being the lack of a contingency plan or the appropriate technology to carry out their courses in line. | Aguayo et al. (2021) [7] | | |

## IV. Discussions and Conclusions

The university digital gap and academic performance, led to important findings as an effect of examining the approaches in various authors.

Before the pandemic, a separation of technological tools within the university education system was notorious "there is a disjunction between the instructional practices of the educational system and the students it is expected to serve, particularly with respect to the roles of technologies digital" [32] [6].

In the times of the pandemic that began in 2020, internet connectivity was inefficient, this is related to the level of economic income and the geographical contexts, mainly differentiated in urban and rural areas [33].

During the pandemic, several authors agree on the fact that technology does not affect the teaching-learning relationship, rather it is clear that academic performance has been optimal because virtual assessments allow high grades, perhaps due to the lack of full management of the tools. by teachers "an increase in the academic performance of students in emergency remote teaching is shown , which is supported by the idea that organizational factors can contribute to the successful implementation of emergency remote teaching" [58 ]. The use of technology by teachers is improvised, it is not the product of a critical process [12].

In the years 2010 to 2019, a disunity of virtual technological tools in university educational systems was notorious [32]. In the mentioned years it was common to perceive with concern the use of technological devices and virtual platforms, due to the loss of autonomy, responsibility and critical sense in the student. [18] [60].

The technological gap in the years of the 2020 and 2021 pandemic disadvantaged the teaching-learning process, generated by limited internet connectivity and educational platforms [33]. Non-connectivity had a higher incidence in a low socioeconomic level and in the rural geographic context. An important point of the digital divide extends to the non-mastery of educational tools and platforms by teachers. [44]. Academic performance, however, within the pandemic years was not affected; on the contrary, student grades were the same or higher than in non-pandemic years. [7]

The technological incorporation in the universities was necessary in order to generate changes in the training processes of the universities, the expansion of training in new digital learning environments led to diversify work methods [8]. Challenges remain to refine processes, digital inclusion models [47], close technological gaps and decisively address specific and innovative educational processes. [49]

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