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Infraestructura tecnológica en tres instituciones educativas públicas en Colombia.

Technological infrastructure in three public educational institutions in Colombia

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RESUMEN

Palabras Clave:

Infraestructura tecnológica; salas de sistemas; tecnología e informática; instituciones educativas.

El presente artículo de carácter investigativo tiene como principal propósito describir el estado actual de tres instituciones educativas en Colombia en lo concerniente a las salas de sistemas a partir del testimonio de tres docentes del área de tecnología e informática. Para esta investigación se utilizó un enfoque cualitativo, el método de la teoría fundamentada, la técnica de la entrevista en profundidad y como instrumento un cuestionario con preguntas abiertas; igualmente, una revisión documental mediante una ficha de recolección de datos. Los resultados muestran que muchas instituciones educativas carecen de los recursos tecnológicos que coadyuvan a mejorar los procesos de enseñanza y aprendizaje. Las conclusiones develan que si bien es cierto existen políticas públicas en relación a dotación de infraestructura tecnológica, falta seguimiento y acompañamiento, igualmente, por parte de las instituciones educativas en establecer desde la planeación los recursos para los mantenimientos a través de un cronograma de actividades.

ABSTRACT

Keywords:

Technological infrastructure; system rooms; technology and computing; educational institutions.

The main purpose of this investigative article is to describe the current state of three educational institutions in Colombia about to systems rooms based on the testimony of three teachers around technology and information technology. For this research, a qualitative approach was used, the grounded theory method, in-depth interview techniques and a questionnaire with open questions as an instrument, as well as a documentary review through a data collection form. The results show that many educational institutions lack the technological resources that help improve the teaching and learning processes. The conclusions reveal that although it is true that there are public policies in relation to the provision of technological infrastructure, there is a lack of follow-up and support, equally, by educational institutions in establishing, from planning, the resources for maintenance through a schedule of activities.

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Introduction.

Technological infrastructure is an issue that has been raised by many authors in the last two decades, firstly, from the provision of computers to educational institutions, making use of the different programmes of the Microsoft Office suite, before the massification of the internet, to our current times, impregnated with multiple devices and applications that together with a connection to cyberspace, allow the optimisation of teaching and learning processes that translate into better results for students in internal and external evaluative tests.

Colombia is lagging behind in terms of the digitalisation process, millions of its inhabitants do not have internet, computer and other media-related elements; in addition, there is a marked gap between the urban and rural sectors. With regard to the above, Pérez (2020) states that “the state in which the public policy of digital government is in with the emergence of COVID-19 aggravates the crisis situation that rural areas in Colombia are experiencing” (p.144).

In allusion to the above, some studies such as Muñoz, Mendoza and Franco (2020) in the Wayuu indigenous community found that “there is a low presence of technological infrastructure to execute the different services or needs” (p.340), which would enable better training and make them more productive in the workplace.

As explained in previous lines, some public policies must be considered in relation to the provision of computer equipment, the management of educational institutions before municipal and national entities for their acquisition, the problems that underlie within the classroom systems. In this sense, Fajardo and Cervantes (2020) agree with the need for “governments and educational institutions to budget for investment in advanced technologies” (p.105), as well as the conditions in terms of technological infrastructure in schools are visualised for the post-pandemic.

In the study conducted by Molina and Mesa (2018) in 10 schools in the rural sector of the city of Tunja, they

found that “the institutions do not have stable and permanent connectivity, and power failures are frequent, teachers have opted for alternative strategies, such as off-line software, audiovisual material projected from video beams” (p.89). In this respect, Bravo and Quezada (2021) express that “it is important for high school graduates to have competences in the use of ICT, given that when they enter university or the world of work, competences related to the use of applications, simulators and different types of programmes are demanded” (p.20).

Within the framework of the above considerations, it is relevant, first, to address the concept of technological infrastructure, taking into account the definitions given by various authors, as well as its etymological origin, which is very important to determine the origin of this concept. Likewise, a characterisation of the technological infrastructure in some regions of the country will be established.

This is followed by a description of the different public policies from the Ministry of Education, the Ministry of ICT (Information and Communication Technologies) and the central government in terms of the provision of technological resources and connectivity, programmes such as Compartel and Computadores Para Educar.

Likewise, an analysis is made of the problems faced by educational institutions in different contexts, the rural and its wide backwardness in many aspects, among which are highlighted lack of electricity and connectivity; in addition to providing a look at the physical conditions where these technological devices are used, and other additional elements such as video beams, smart boards, speakers, as well as the technical support provided to them.

Thus, this research is important in that it provides teachers with an overview of public ICT policies in educational institutions, which invites them to become aware of the legal framework that governs them and thus be able to communicate with the different programmes and entities, lodge appeals with them through petition rights as part of the management of

infrastructure and, on the other hand, learn about the services they provide; likewise, to see how in various educational institutions there are similar problems to the place where teachers work. And finally, to serve as an input for state entities to improve certain processes related to access to technological infrastructure in educational establishments, considering the information provided in this study.

Materials and Methods.

This article is framed within the interpretative paradigm, which seeks to understand social realities through communication where knowledge is shared by placing oneself in the place of the other, which allows explaining certain actions and behaviours of people (Roca, 2020, p.2); that is, the experiences of everyone are taken into account, which offers an overview of reality from different perspectives. In addition, a qualitative approach was used, where according to Carhuacho, Nolazco, Sicheri, Guerrero and Casana (2019) “natural situations are investigated, trying to make sense of or interpret the phenomena in terms of the meaning that people give them” (p.14). The method selected was grounded theory, by means of which categories were constructed that emerged from the data provided by the key informants, who were essentially teachers in technology and computer science in three educational institutions in the Departments of Antioquia, Atlántico and Magdalena.

Grounded theory “recognises as the primary characteristic the grounding of concepts in the data” (Strauss and Corbin, 2002, cited in Jiménez, García, Cardeñoso, 2017, p. 35), so that theories can be built from the data, very useful for addressing problems where it is necessary to take a holistic view of reality trying to understand and interpret it through strategies of constant comparison that involves the collection, coding and analysis of information.

It was considered the technique for data collection of the in-depth interview by means of a questionnaire of questions concerning the technological infrastructure of their educational institutions, being this technique valuable to collect important information provided by people who have experience associated with

the object of study, in this sense Sordini (2019) states that this technique “invites conversation, generates a space of intimacy and trust and, assumes that the interviewee is an expert on the topic of interest because the information reported has been experienced and interpreted personally” (p.80); in addition, the documentary analysis technique was used, which is useful according to Reyes (2019) because it helps to confront the evidence found and in turn, giving the possibility of creating new hypotheses or conceptual models.

To collect the data, a registration form was used in which an exhaustive search was carried out for articles on the following topics: technological infrastructure in educational institutions, ICT public policies and the state of systems rooms in Colombia: Technological infrastructure in educational institutions, ICT public policies and the state of systems rooms in Colombia, which involved a bibliographic search through search engines such as Google Scholar and databases Redalyc, Dialnet and Scielo; The most relevant and updated on the subject were selected, then proceeded to organise the information found in a table prepared in the Microsoft Office Word program, which allowed analysis, comparisons, establish differences and similarities between authors, documents were taken into account from 2016 to 2021 and some others outside this date range to a lesser extent, but for their valuable contributions were taken into account in the research. This search was carried out between March and October 2021, essentially in Spanish.

Results and Discussion.

From the descriptors that were taken as a reference for the search for relevant information on the subject studied from the various positions of authors where pre-categories were established and then interviews with teachers in the area of technology and computer science, the codes were extracted by open coding, with which the categories and subcategories were determined through axial coding, the relationships between them were established, then the central category emerged, the other categories were integrated and refined around it. Finally, the theory is presented in which the conceptualisations of each of the categories were deployed, considering the review of the research

background, the data provided by the key informants and supporting bibliographical sources that support certain positions, either validating or refuting the arguments provided in the interviews. As a result, four main categories emerged: definitions of technological infrastructure, technological infrastructure in educational institutions, ICT public policies in Colombia and the state of systems rooms in Colombia, which are presented below.

Definitions of technology infrastructure

The first emerging category was called Definitions of technological infrastructure, which involves having the basic notions about the object of study that is being addressed; this allows for a clear identification of the concepts that are being dealt with, which helps to guide the researcher and key informants on the subject in a more precise way. From this category, two subcategories could be revealed; the first refers to the definition of infrastructure, and the second to the concept of technology to consolidate a clear starting point for the topic under consideration as a whole.

Technological infrastructure has been a cornerstone for human beings in recent times, since it has allowed them to carry out various tasks and activities in different sectors of society, including those related to the field of education, thereby optimising and improving processes, increasing efficiency by having the required hardware and software and thus offering a quality service in accordance with educational purposes and institutional horizons. This is why its study can be found widely investigated by various authors in this contemporary era, characterised by a population of immigrants and digital natives, who are closely linked to new technologies. Accordingly, there are multiple definitions of infrastructure that will be considered below.

Etymologically, the word infrastructure, according to Etymologies (2020) is derived from a prefix and a word, “the Latin prefix *infra* - below - and the word *structure* - the skeleton or parts supporting a building”. (p.1). On the other hand, the dictionary of the RAE (n.d) -Real Academia de la Lengua Española- defines technology as a set of theories and techniques that allow the practical use of scientific knowledge,

this is consistent with what an informant expresses during the interview, after inquiring about his opinion on the concept of infrastructure:

In my opinion, I think that the infrastructure is about everything that is needed in the school to give classes, the classrooms, the computers, the projector, the printers, as I explain..., all the physical part that we must have to teach the students (Informant 1).

In this sense, the technological infrastructure frames a series of elements which must be closely related to each other. In this regard, López (2016) states that technological infrastructure “is made up of a set of interconnected hardware and software in fluid interaction” (p.10). In this regard, a key informant states the following: “technological infrastructure has to do with the devices and tools, but also the programmes we use, also the internet, social networks, the virtual classroom” (Informant 2), i.e., through technological infrastructure they become real agents of change and social transformation, enabling the improvement of classroom environments that contribute to a substantial improvement in the teaching and learning processes.

This is consistent with Muñoz and Campuzano (2019), who state that “the use of computers and the internet improves educational practices, making learning more relevant for life” (p.15), being used for problem solving, product development, among others.

Technological infrastructure in educational institutions

Undoubtedly, the technological infrastructure has played a transcendental role in recent times since it has led to significant advances in various fields for humanity. In the education sector, this has not been the exception, since technologies have made it possible to generate learning environments full of many computer tools that are of interest to students, including the possibility of accessing a large amount of content in various formats -audio, video, text-, deployed on the Internet, in addition to the use of very friendly virtual teaching and learning environments with characteristics similar to those of a social network; Such

is the case of Edmodo to cite an example, the truth is that to carry out these school environments conducive to learning it is necessary to have computer equipment and connectivity that enable the performance of the teaching work in all its dimension, in this sense Cruz, Pozo, Aushay and Arias (2019) state:

Thanks to the presence of the Internet, which makes it easier for learners and educators to obtain the information they need about the topics that are of interest to them or are being dealt with in the curriculum and within their curiosities. (p.8).

It can be seen that many educational institutions do not have the indispensable and necessary technological infrastructure to meet the objectives and goals that have been set; for example, in the study by Sierra, Romero and Palmezano (2018) they state that: “the computer rooms that have public educational institutions in the city of Riohacha, 90% of teachers say that these computer rooms do not have the appropriate number of computers, the infrastructure is deficient” (p. 39), which is similar to what is expressed by informant 1, who mentions that “most of the computers are damaged, the ones that half work have many problems, they do not allow programs to be installed, they are missing programs, they are missing computers, and they do not have the necessary equipment” (p. 39).), which is similar to what is expressed by informant 1, who mentions that “most of the computers are damaged, the ones that are half working have many problems, they do not allow the installation of programmes, they lack keys, they are slow, nine out of 40 computers are useless”.

According to the report delivered by MinTic (2021), there are some departments in Colombia that are lagging in terms of internet access in different environments, whether at home, at work or in educational institutions. The indicators show the great disparities in the territories, departments such as Guainía, Amazonas and Guaviare are positioned in the last places percentage-wise in the number of people accessing the internet from educational institutions, this is evidenced in the study conducted by Dane (2020) cited in Pérez, Ramos and Casas (2020) who state that before the pandemic in Colombia, “66.1% of educational institutions did not have internet connection; This

situation was aggravated in rural schools, 78.7% did not have internet connection; 8% did not have electricity and 68% did not have televisions” (p. 13); the above is related to what was stated by one of the key informants, who affirms that “here in the municipality the internet has not arrived, much less in the school, we are waiting for the internet promised by the government, for now we make technological objects with recyclable materials” (Informant 2).

There are other types of problems associated with connectivity within educational institutions, and in some of them, where they have internet service, there are other types of related difficulties, one of the key informants who works in an educational institution in Barranquilla states that “the internet works well in the computer room where we use nine computers, but the other teachers in the classrooms behind the school do not receive the signal” (Informant 1). In the same vein, a similar situation is presented by informant 3, who is employed as a teacher in an educational institution in Bellavista, a village in the municipality of Concordia in the department of Magdalena:

Unfortunately, there is only internet in what used to be the computer room, now the library, ... There is no internet access from the classrooms, ... Even though the service provider was recently changed, the coverage is the same (Informant 3).

The above is collated with a report on public educational institutions in the municipality of Chía-Cundinamarca, where Fernández and Barajas (2018) state that: “they frequently run out of service, browsing speeds are too low to download the content required by each student and research must often be done at home” (p.12), which makes it difficult to enhance certain aspects such as problem solving, creativity, collaborative work, the ability to learn by discovery, necessary for the development of basic skills in fundamental areas such as reading, writing and science. In the same vein, educational institutions in Sincelejo are in a similar situation, as expressed by Lengua (2016) in which he argues that “ICT-mediated training processes are incipient, due to the precarious technological endowment and inadequate building conditions”.

Regarding the ratio of number of computers per students in educational institutions, there is a study carried out in the city of Bogotá which shows a high number of students per available computers, according to Idep (2020) cited in Ballén, Ramírez, Baquero, Padilla and Bernal (2020) who state that “the data for the indicator, already normalised, show a percentage of compliance with the index of less than 36% between 2016 and 2019” (p.5).), this is consistent with what was expressed by informant 1, who states “my computers are from 2012, we already have nine years with them, the first year there was a warranty and they did maintenance, but after that many were damaged, they do not fix them, nor do they change them” (Informant 1). Similarly, Informant 3 states that “we don’t have enough computers. Of the few computers we have, some are in bad condition”.

Although it is true that there is computer equipment, it is insufficient for the number of students in the educational institutions, which means that they have to work in teams of three or four students, as well as sharing them between the different school days - morning, afternoon, evening, night - which leads to greater wear and tear on these devices.

Public policy in Colombia in relation to technological infrastructure in educational institutions

Public policy associated with the field of education in terms of technological infrastructure can be approached in two large blocks or subcategories: firstly, those related to connectivity, i.e. those policies and laws that have managed to bring the internet to educational institutions throughout the country, and secondly, the programmes that have been responsible for equipping classrooms with computers, tablets, video beams, as well as training teachers in the use of different digital resources.

One of the first was the Compartel programme through the Ministry of Communications, which, according to Guzmán (2019), was intended to “provide educational centres with the necessary resources to access information and generate new teaching-learning processes with the use of computers” (p.132). In addition, it made it possible for many people living in remote areas to have access to telecommunications

services (Compartel, 2004, p.13), making it possible to connect to the internet essentially in rural areas and in conditions of vulnerability throughout the country.

Another of the flagship programmes that is still in force today is Computadores para Educar -CPE-, which according to Cpe (2021) is a “National Government programme that promotes educational innovation, through access, use and appropriation of technology in the country’s educational establishments” (p.1), which “was established through the document of the National Council for Economic and Social Policy (CONPES) 3063 of 1999” (Sánchez, Saavedra, Figueroa, 2020, p.307), while Unacional (2018) states that “the expectation has been that computer equipment will be used in educational establishments in general as a pedagogical tool, for example, in computer instruction and bilingualism programmes” (p.8), i.e. on the one hand, the aim is to provide schools with computers and internet access; and on the other, to implement the necessary pedagogical strategies characterised by being innovative that achieve the achievement of significant learning in students.

One of the problems is the replacement or updating of computers, which in many circumstances does not occur in the required time, as expressed by informant 3 “Of the few computers we have, some are in poor condition”, this happens because the CPE programme supplies remanufactured computers, in this sense, according to Rueda and Franco (2018) state that CPE “brought to rural schools recycled computers that after a few months were no longer useful, so that the educational institutions and communities were forced to finance the purchase of their own equipment” (p. 16). Better management and monitoring of the condition of the devices that are delivered to the educational institutions is therefore necessary to guide decisions on preventive and corrective maintenance, making the programme more efficient.

It is necessary for new technologies to reach all corners of the national territory, in this sense, the Mission of Wise Men gathered in 2019, stressed the urgent need for “computers or tablets and internet connection in all educational institutions in Colombia” (Sabios, 2019, p.196).

The Ten-Year Plan 2016-2026 within its strategic guidelines concerning infrastructure emphasises the conditions that must be in place within schools to adequately carry out the teaching and learning processes, in terms of technological tools, digital content, teacher training, among others, in this sense Men (2017) states that it should seek to “guarantee the technological infrastructure and the physical and connectivity conditions of official educational institutions throughout the national territory, prioritising the areas with the greatest needs” (p. 54).), which is a great challenge because there are many gaps to be filled even in urban contexts where one would think that general conditions would be notably better, for example, an informant commented the following “the internet was removed while we were in pandemic, the roof collapsed because of the rains last year, several computers stopped working, as well as the electricity in the computer room” (informant 2).

It is therefore necessary to optimise the incident reporting mechanisms, i.e., effective monitoring of the ICT infrastructure in each institution by the different Education Secretariats of the certified territorial entities, the Ministry of Education, and the Ministry of ICT in a joint effort.

Implementation of technological infrastructure in educational institutions

Nowadays, ICT in schools has brought about significant changes, as it allows for the creation of innovative classes by using a range of computer resources that can make it possible for all areas of knowledge to be used in a cross-cutting manner. This means that certain conditions must be established in the educational institution’s premises where this computer equipment is used.

Considering the above considerations, there are certain difficulties in many schools in Colombia, for example, Herrera (2020) mentions the poor state of the systems room, which is very deteriorated, damaged floors, roof cover in poor condition, lack of sockets to charge laptops, tables to place computers and teachers’ desks without firm bases that can cause them to fall. Likewise, in Barrera, Bernal and Ángel (2019), they show how “computer equipment pres-

ents deficiencies in terms of hardware and software, because they have already completed their useful life cycle and have not been replaced” (p.19), it is important to make the relevant interventions to replace the computer resources that have breakdowns; and on other occasions the possible solutions to solve the problems based on their diagnosis and repair in optimal times.

Another problem to consider is the time of access to technological devices within educational institutions, in this sense López and Villa (2017) state that “access to ICT in the classrooms of the institution is very low, almost null, because students have access to computer rooms only two (2) hours a week” (p.50). With reference to the above, informant 2 mentions that “in the school they only use computers for computer science and one hour per class, because the other hour of the area is for technology and no computers, the other subjects have a computer and a video beam that the other teachers fight over”.

Other factors that affect the proper implementation of technologies within educational institutions is the lack of technological elements that make possible a better classroom environment in terms of teaching resources including video beams, smart boards, speakers, televisions, among others, many schools lack these resources, as stated in the study of Guzman (2018) in which students say that they should “acquire more video Beam, as in the institution there is only one for the main office” (p. 30).), however, it should be noted that the circumstances may be different in other educational institutions that have some elements and lack others, for example, in terms of video beam an informant comments “Of video beam if we are fine. There are approximately five” (Informant 3).

Along the same lines, in the school La Belleza Los Libertadores, the tablets delivered by the CPE programme present some problems to be able to use them, as expressed by Cortés (2018) “the tablets are without chargers, therefore, although they have access to internet and they work, they cannot be used because there is no possibility of connecting them to a power network” (p.51). This is evident in many educational institutions in the rural sector and contributes to school dropout, alternatives such as solar panels or

wind energy could bring electricity to many remote parts of the country.

There are other even more serious problems, such as the lack of electricity in educational institutions, which frequently occurs in those that are located in rural areas, very far from the urban centre, villages where the power towers are very distant, such is the case of the municipalities of Rioblanco, Ataco, Ortega and Chaparral in the department of Tolima where, according to rcentral (2020), “they lack electricity service, which does not allow them to take advantage of government programmes that have benefited the region, such as computers for education, Ortega and Chaparral in the department of Tolima where, according to rcentral (2020), “they lack electricity service, which prevents them from taking advantage of government programmes that have benefited the region, such as computers for education, more than 80 schools with 196 computers are out of operation in these rural schools” (p. 83). Contrary to the case expressed above, informant 3, who is in the rural area, affirms that “we have always had electricity, the problem is that when Electricaribe was there, the electricity went out frequently, but you know, that is normal”.

On the other hand, it is common for educational institutions to have one or a group of teachers who install some additional programmes in addition to those that come from the factory, as informant 2 states “once the computers lose their guarantee, that is, after about the second year, I can fix them, as I say..., install operating systems, pirate office, install a memory or hard disk so that it works and other things”, while informant 3 affirms “The truth is that there is no maintenance done on the equipment. And it has rarely been done since I have been working in the institution”.

These situations show that educational institutions do not have a maintenance plan from planning to be executed according to a schedule, which has certain resources for this purpose, this is evidenced in Guzmán (2018) when it is stated that “technical support is not contracted, technology teachers sometimes provide this service in their free time” (p.32), so it is necessary to hire qualified technical personnel or establish strategic alliances such as SENA to provide this service and the teacher fulfils the functions that

really correspond to him.

Conclusions.

Teachers must work in conditions that allow them to carry out their work in the best possible way to achieve the results set out in the area plan and the PEI. If this is not done, a series of problems are generated, such as loss of time in the execution of content due to the lack of computer equipment in good condition.

Educational institutions must have a preventive and corrective maintenance plan at least once a year to ensure the proper functioning of the systems rooms, which will also allow them to keep track of the number of computers in good condition and those that must report to Computadores Para Educar, the entity that is responsible for the replacement of laptops in public educational institutions in Colombia.

Regardless of all the infrastructure problems, the educational institution is called upon to act before the competent bodies, either at the local level through the secretary of education or at the national level through programmes such as Computadores Para Educar, which are responsible for providing schools with computer equipment such as tablets and laptops.

The above indicates that, despite the existence of public policies to bring technological equipment to educational institutions, as well as connectivity, there is still much to be done in scenarios such as in rural contexts and also an optimisation of the processes of replacing computers that have already completed their life cycle, especially in regions of the country that require it most due to poverty levels and students' results in national tests, as Sánchez, Reyes, Ortiz and Olarte (2017) cite “there is still a lack of efforts to improve technological conditions in the national education system, particularly in the north and east” (p. 138), which make possible the provision, expansion and improvement of technological infrastructure.

Finally, it is important that the resources that are approved by Congress and sanctioned by the President of the Republic are executed with the greatest efficiency, establishing standard specifications where

technical, economic and experience parameters are established for the selection of contractors to carry out a specific work for the purposes of this study, those concerning technological infrastructure, determining the criteria for the correct selection of project supervisors, as the current situation for schools in rural areas in Colombia in terms of connectivity is worrying, a scandal is opening up in which 70 billion pesos in advances to the Centros Poblados contractor and a series of irregularities have been committed.

The former ICT minister, Karen Abudinen, stated that the respective investigations were being carried out, and added that the money would not be lost, the contractors would have to assume their responsibilities to society and essentially to the schools that have been left without connectivity (FM, 2021). Meanwhile, hundreds of children and young people in municipalities and villages across the country have not been able to access a world of knowledge that would allow them to have a better-quality education.

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