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DIGITAL COMMUNICATION IN SCIENTIFIC PRACTICES: LIMITATIONS AND POSSIBILITIES FOR EQUALITY

COMUNICACIÓN DIGITAL EN LAS PRÁCTICAS CIENTÍFICAS: LIMITACIONES Y POSIBILIDADES PARA LA EQUIDAD

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RESUMEN

Las tecnologías de la información y la comunicación se han distribuido de manera desigual entre los países, reproduciendo fielmente los patrones existentes de desigualdades de poder en todo el mundo.

En el presente trabajo analizamos los usos de las tecnologías digitales de la comunidad académica en Latinoamérica, sus funciones, limitaciones y potencialidades con el fin de construir un marco común que permita la mediación de las tecnologías en la producción de saberes y el desarrollo de redes de colaboración equitativas.

Hemos analizado 18 entrevistas a investigadoras e investigadores de Universidades tecnológicas latinoamericanas, como estrategia analítica se realizó un análisis de contenido temático.

Hemos evidenciado que las tecnologías digitales actúan como infraestructura necesaria para: (a) la creación de redes entre profesionales e instituciones con el fin de sortear dificultades materiales; (b) la búsqueda y acumulación de información; (c) la producción de conocimientos y la mejora de la capacidad competitiva; (d) la diseminación y aumento de la visibilidad de los resultados de investigaciones.

A pesar de haber evidenciado dificultades en cada uno de los cuatro puntos analizados, la transformación digital abre nuevos escenarios que permiten establecer espacios de colaboración y producción de saber, algunos de ellos podrían ayudar a democratizar la práctica científica en territorios de precariedad.

PALABRAS CLAVE

Transformación digital; Acceso Abierto (AA); prácticas científicas; equidad.

ABSTRACT

Information and communication technologies have been distributed unequally across countries, reproducing existing patterns of power inequalities around the world.

In the present work we analyze the uses of digital technologies of the academic community in Latin America, its functions, limitations and potentialities. This, with the purpose of building a common framework that allows for the mediation of technologies in the production of knowledge and the development of equitable collaborative networks.

We have analyzed 18 interviews with researchers from Latin American technology universities and made a thematic content analysis.

We have evidenced that digital technologies act as necessary infrastructure for: (a) the creation of networks between professionals and institutions in order to overcome material difficulties; (b) the search and accumulation of information; (c) the production of knowledge and the improvement of competitive capacity; (d) dissemination and increase of the visibility of research results.

Despite having evidenced difficulties in each of the four points analyzed, digital transformation opens new scenarios that allow to establish spaces of collaboration and production of knowledge, some of which could help to democratize scientific practice in precarious territories.

KEYWORDS

Digital transformation; Open Access (OA); scientific practices; equity.

1. INTRODUCTION

Digitization refers to the socio-technical process of using digital technologies in social and institutional contexts as an infrastructure for daily practice (Tilson et al., 2010). The habitual use of such technologies in the processes of communication, production, and collaboration in the various spheres of daily life gives rise to the digital transformation.

The distribution of information and communication technologies (ICT) and access to the Internet has been uneven in most developing countries (Ahmed, 2007), despite the fact that these (ICTs) are often thought of as potentially useful tools to promote the economic and social development of a territory. This aspect has the consequence of reproducing the patterns of inequalities of power throughout the world (Castells, 2001, Wellman and Haythornthwaite, 2002).

Specifically, Latin America has been characterized as a territory of late and limited production of digital technology (Berrío-Zapata, Jorente, and Santana, 2014). Thus, this continent is located on the border of the development of knowledge and infrastructures that make digital transformation possible and require the support of other countries for its development. From the border of technological development, Latin America extends the use of the Internet in the university sphere since the late 80s and early 90s under the support of non-peripheral countries (Berrío-Zapata, Jorente, and Santana, 2014) and with a fractional and unequal extension according to the university and territory (Gayosso, 2003). Despite the fact that since the 90s Latin America has had a huge involvement in the process of digital transformation for productive, social and research development, its development is usually focused on the use and not on production (Berrío - Zapata, Jorente, and Santana, 2014). Likewise, the use of digital technologies in the Latin American context is located in a social structure characterized by social and economic inequalities added to the limits of institutional infrastructures, which are aspects that limit the access and exploitation of digital technology (Peres and Hilbert, 2009).

Due to the disparity of production conditions and access to information technologies present in Latin America, researchers may have difficulties accessing important sources and resources for scientific practice. Inequality in access to information and in technological advantages between researchers becomes a crucial factor in science. Indeed, the process of digital transformation is not arbitrary or innocent and on the contrary, it contributes to the exercise and distribution of power in society (Silverstone, 1999). This means that digital transformation could produce a digital gap (Rice, 2001) between countries where Internet access and information and communication technologies are not distributed in the same way (Benkler, 2006, Balkin, 2010, Gómez y Bongiovani, 2012, Shaver, 2007). This distribution results in unequal access to data sources, publications, scientific networks, infrastructures, etc.

Inequality of access to information and technological advantages among researchers is translated into inequities in the production of knowledge and its communication. In this framework, Open Access (OA) usually appears as a condition of possibility to equalize the balance and reduce the barriers that certain territories and collectives have to access knowledge. Suber (2015) highlights that Open Access reduces the economic and infrastructure limitations that some countries, institutions and/or people in Latin America have, to facilitate their participation in knowledge networks and increase the impact of their research at a global level.

Under this logic, since the beginning of the 2000s, there has been a succession of declarations and agreements in Latin America that have sought to promote the development of Open Access policies in the region. The following points stand out (Babini and Fraga, 2006; Suber, 2006; Sibele, 2013) :(a) The manifesto of support for scientific information in Open Access, aimed at promoting open publication; (b) The Salvador Declaration on Open Access (2005) that highlights the importance of increasing Open Access in developing countries as a strategy for the democratization of knowledge among researchers; (c) The letter of San Pablo (2005), where the importance of ensuring access to the production of scientific knowledge for social development predominates; (d) The declaration of Florianópolis (2006) and (e) the declaration of Cuba (2007). The last two highlight the importance of promoting Open Access in Latin America.

The actions to promote Open Access in Latin America are reflected in the extensive development of Open Access networks. Thus, LatinDex was created in 1995 (Latindex 2018), Scielo in 1997, and RedALyC in 2002 (Alperin, JP et al., 2014). Gaiza (2016) highlights that the presence of repositories and the publication of Open Access is a common practice in Latin America. However, the author points out that despite the presence of Open Access journals and repositories in the region, pressures to publish in journals with high impact indexes, commonly published in European and North American countries, limit the practice of Open Access to Latin American scientific productions, because many of the impact journals are closed access.

In a scenario of disparate evidence, which, on the one hand, highlights the importance of digital transformation in scientific production and collaboration practices, and on the other hand demands the consideration of its unequal distribution in Latin America, we focus on analyzing the potentialities and limitations that the digital transformation offers the researchers in their daily practice for the construction of inclusive and equitable scientific communication from the Latin American reality. We propose to analyze the uses of digital technologies of the academic community in Latin America, their functions, limitations, and potentialities in order to build a common framework that allows the mediation of technologies in the production of knowledge and the development of collaborative networks.

2. OBJECTIVES

This article is based on the analysis of the interviews with scientists from Latin American institutions carried out for the development of the EULAC Focus project. We focus on the effects of digital transformation on the processes of collaboration and scientific communication.

We focus on the uses of digital technologies for the production of scientific knowledge in Latin America. Specifically, we propose: (a) to analyze communication practices among institutions, in order to establish networks of academic collaboration; (b) to unravel the value of digital technologies in the knowledge production process; (c) to know the strategies developed by researchers in the process of knowledge production that allows to reduce the digital gap; (d) to identify communication strategies between professionals and institutions in order to visualize the knowledge produced.

3. METHODOLOGY

The study is based on the qualitative methodology because this allows us to access the complexity and dynamism of the social practices in a specific and deep way. (Ruiz Olabuénaga J 2012).

42 interviews were conducted with researchers from European and Latin American technology universities, although in this article we will focus only on Latin America (18 interviews conducted in 2016 in Ecuador and Mexico). The people interviewed are the most active researchers in their universities. For the selection of the most active profiles according to the academic institution, we have identified in the Scopus databases those who publish the most in the selected universities.

The interviews were conducted in person by the researchers who collaborate in the EULAC Focus project in the different institutions. They followed a semi-structured, dynamic, and flexible script, with the aim of making room for the narratives of the people interviewed (Muntanyola and Belli, 2016). The following topics were included in the script: daily activities in the research work; institutional collaborations; the use of digital technologies for research and scientific collaboration; learning of digital technologies for research practice; access to digital technologies; use of open access; use of open software; strategies and tools for the dissemination of knowledge, digital transformation and innovation.

The reason for choosing interviews as a means to collect information is that they allow access to detailed information about different events and situations without the need of the researcher's presence at the time they occur. Likewise, its communicative nature allows to capture complex meanings through which people reconstruct their experience (Rubin HJ, Rubin IS., 2005) of the use of digital technologies in research practice.

The ethical regulations on the recollection of data from people were met according to European Union regulations and the institution we belong to. All the people interviewed were informed about the objectives of the interviews, and the usage of data and its confidentiality were guaranteed. This way, each participant provided inform consent. The names of the interviewees were also left anonymous. The names that appear in the extracts are fictitious and serve to identify the interview conducted.

An analysis of thematic content was carried out (Braun V, Clarke V. 2006) with the purpose of identifying the main practices in the research work. Once all the interviews were transcribed, we identified potentially relevant segments for the research objectives (Coffey A, Atkinson P, 2003). Thus, in the first phase of analysis, we established an open code identifying thematic blocks on production practices and scientific communication. Subsequently, we identify different subtopics assigned to each thematic area.

Then, we elaborated a conceptual diagram (with help of the Atlas.ti program) and condensed the information of each topic and subtopic from the compilation of the statements made explicitly by the people interviewed, limiting the interpretation of implicit connotations to comments added in the form of external notes and thematic groupings.

By linking the complete interviews with the extracts that belonged to each topic and subtopic analyzed from the conceptual diagram, we made the categories and subcategories presented

below. With these tools, we were able to create an image about the use of digital technologies in collaborative practices and scientific production.

4. RESULTS

Scientific practices are continuously mediated by the use of digital technologies, acting as a necessary infrastructure for the production and dissemination of scientific knowledge.

Extract 1

> "Technology has actually become one more limb of my body" (Mayo)

In this sense, the scientists interviewed highlight the use of technology to (Image 1):

a) Create communication networks between professionals and institutions in order to overcome material difficulties of certain institutions or research groups that occur.

b) Search and accumulate data and studies as a basis for the production of new knowledge;

c) Produce new knowledge and improve the competitive capacity of research groups;

d) Disseminate the knowledge produced by increasing the visibility of scientific production to peers and to civil society.

4.1. CREATION OF COMMUNICATION NETWORKS

In the first place, the people interviewed expressed that new technologies work as a communicative bridge between professionals inside and outside the institutional environment, breaking the traditional time-space structure. In this sense, neither the real presence of technologies, objects, and people nor the temporal correspondence of the interlocutors in the communicative exchange is essential to maintain institutional links and exchange knowledge.

Extract 2

> "Digital technology has made history in all kinds of aspects, mainly in the communication between researchers, which is now instantaneous no matter where the person is." (Nelly)

Thanks to digital technologies, there are professionals with similar interests, networks of scientific collaboration are created, and institutional links are maintained over time.

Extract 3

> "Skype, I speak with them once a week or once every two weeks, and by email daily." (Paloma)

Likewise, the potential of digital technologies to make people in different spaces and times present in virtual environments facilitate coordination in the development of collaborative works.

Extract 4

> "I love social networks to communicate, they make the work process much easier than, for example, 15 years ago. I constantly use them to coordinate an activity or meeting with people linked to my project, because many times you work with many people who may not be or who do not work in the same place as you." (Hortensia)

The communication technologies widely used for informal communication such as Skype, WhatsApp, and e-mail, are taken as necessary and indispensable infrastructures in scientific practice since they allow for the establishment of new contacts and the maintenance of links between professionals and institutions.

There are tools that are used daily in private lives (Skype, WhatsApp, etc.), which are starting to be used also in working lives. Many of them, although they were not born with this objective, find space in the professional setting because their informal dynamics facilitate the fast and flexible communication.

Extract 5

> "I think email is a hundred percent necessary (...) Social networks play a fairly important role that I would expect when it comes to scientific research and relationships. Through Skype, WhatsApp, among others, we are able to send large amounts of project data and to coordinate activities, meetings, etc. efficiently, and, more importantly, instantly, since time is precious in science. There are other social networks like LinkedIn or ResearchGate that are very useful when you try to find colleagues to work with or to find new work projects or even to download documents from people related to your field". (Nelly)

In this extract, we show how in the last decade social networks have taken the spotlight in interpersonal communications. This phenomenon is repeated in several aspects of life, not only in the private. Thus, there are social networks focused on labor relations, and more specifically on scientific ones. This way, it is possible to share information about scientific achievements, publications and projects in a scientific community that is increasingly relevant in the digital world, as mentioned by the person interviewed, Nelly.

4.2. SEARCH AND DATA ACCUMULATION

Digital technologies are the preferred infrastructure for the search of data and scientific studies that serve as a basis for the development of research. In this sense, researchers say that they use electronic databases to support their research and scientific communications since they facilitate access to information quickly and conveniently by being available, via Internet, in multiple environments.

Extract 6

> "I need to have internet because first I search on a scientific search engine called Pubmed, which is directly related to the National Library of the United States Health Institute (...) I need to do a search, to prepare a class, to prepare a conference, write a scientific

> article, graph and present the data, so, without the computer ... I would not know what to do."(Lilly)

The people interviewed compared Open Access articles to the paid articles as components that may hinder the course of the investigation since institutions or groups with fewer resources have less access to scientific journals licenses. Access to certain areas of knowledge becomes a tedious activity as a result from informal strategies (search for articles by those who institutionally have such licenses).

In this case, they express that inequality in access to information generates inequities in the distribution of knowledge and its subsequent research development.

Extract 7

> "Generally the university has to pay for these licenses to access these journals or newspapers. Unfortunately, I know that [Latin American university] has not paid for any editorial or journal. Then I have to access these journals through the [European] University (...) I am saying that this is the reality and if a university wants to have a good research it has to pay for these licenses" (Paloma)

In many of the interviews, the problem of access to information and databases appears due to the limitations that many Latin American universities have when subscribing to scientific journals. This is one of the main problems that we have evidenced and the cause for what we define as scientific digital divide. This divide is the main cause of the lack of scientific production and sharing of knowledge among researchers in this region. Within the framework of the European project, we are designing an Open Access platform to create a bi-regional infrastructure between countries of the European Union and Latin America and the Caribbean to eliminate this divide.

4.3. KNOWLEDGE PRODUCTION AND COMPETITIVENESS

Digital technologies are present in the same process of data analysis, the people interviewed describe the introduction of digital technology as an element that facilitates greater efficiency of scientific work, allowing the establishment of more precise measures, and faster and more complex analysis. Without them, the analytical capacity of researchers would be limited since doing their research would require more time and effort, among other things, measures, estimates, and graphs.

Extract 8

> "Digital technologies (...) have a huge impact on scientific research. For example I, as a chemist, work a lot with molecular weights and similar things that need extreme precision when measured. Also to map long molecular chains in 3D - which is sometimes needed - or to analyze large clusters of data collected as part of an experimental project." (Hortensia)

Extract 9

> "If you want to automate these things (...) you can involve elaborate algorithms. If you do part of the manual work, it has to be easier" (Leandro)

The importance of digital technologies in the production of knowledge is especially evident in certain statements made by scientists who say that, in some cases, technology is what allows certain data to be collected and its consequent analysis.

Extract 10

> "It makes it possible to generate the data, for example, without a faster camera, a vibrator, and basic materials, there are experiments that I simply could not do" (Leandro)

The efficiency of technologies is especially relevant in a competitive scientific production environment, which prioritizes the fast collection of data, its exploitation, and dissemination. The people interviewed express that, in the absence of adequate technologies, certain groups of researchers located in precarious infrastructure conditions cannot compete with the productive level of institutions and/or opulent countries.

Extract 11

> "Without those tools, we could still do it, but slower, and we could not be competitive. You could not compete with anyone because it's like riding a horse while the rest rides a fast car. There is no comparison, it would be like the old world and the new world and it is very different." (Álvaro)

In addition, digital technologies not only improve the effectiveness of scientific work but also allow virtual infrastructures to be available. That is, to access equipment or perform simulations in institutional contexts of lack of technology. In this sense, they express that digital technologies serve as a patch for situations in which state-of-the-art technologies are not available (duly equipped laboratories, computer programs, etc.) in the institution/country in which the research is carried out.

Extract 12

> "When I don't have the necessary software and hardware infrastructure to carry out the experimental part of the project, I send the data to be analyzed to other centers, such as the School of Biology of the University" [Latin American university from another country] (Nelly)

Extract 13

> "If we need to calculate something complicated with the laptop, we make a remote connection to a computer center in [Europe] and place the calculations in parallel." (Ale)

Extract 14

> "If you take away my laptop or remote control, collaborations, licenses, I will only teach physics." (Luis)

In extracts 12, 13 and 14 we can identify the main problems of access to technology and the effects it would have on the professional lives of researchers. We identify the leading role that these tools have in the daily life of these scientists in their institutions. Also, as mentioned in the preceding lines, a scientific digital divide is created, not only when accessing and sharing knowledge, but also when producing it.

4.4. DISSEMINATION OF KNOWLEDGE AND VISIBILITY

Digital technologies allow the dissemination of knowledge by traditional media faster than in the absence of them, it reduces the time in the publication of research to the scientific community.

Extract 15

> "Dissemination. That´s it ... before, publishing took months because you had to send the article via regular mail, now you send it on an internet platform (...) communication is faster, acceptance, sending the article, its evaluation and acceptance is much faster." (Lilly)

Digital technologies also allow mass dissemination of knowledge and projects without the mediation of peer evaluation to members of the scientific community such as academic platforms, like Researchgate and/or the population in general (through Blogs, Instagram, Facebook, etc.)

Extract 16

> "If you don't disseminate you don't exist. So, if you don't have any kind of publication, you do not exist either. (...) social networks help a lot with this type of dissemination, comments, and international contacts. I have a web page where I upload the same products and the same projects (...) through Facebook I have limited myself to making publications of the products (...) Instagram has been one of the strongest tools" (Moi)

Likewise, the researchers interviewed express the possibilities that digital technologies present when proposing diverse scenarios that open the debate of the findings disseminated to different audiences. First, they allow the general population to have new knowledge. This results in people informed and in turn they act faster in situations that affect them. Second, if digital technologies are aimed at the students, it allows to update knowledge and encourage their interest in scientific advances. Finally, these allow a faster dissemination of results to the scientific community, encouraging debate and improvement of research lines.

Extract 17

> "Journals now allow sharing, you know the link to your research or the new publications that are appearing, in Facebook and ResearchGate mainly." (Luc)

Extract 18

> "In terms of social networks or online social groups, now we can share results and be in contact with people who ten years ago would have been very difficult to send an article to or a map to someone who lives higher up in a volcano, or a coffee farm, but now it's just a click away. Therefore, the ability to share that information is ... really advanced

> and even simple communication during emergencies has come a long way in the last ten years." (Luc)

Evidently, although not all regions of the world have had the same dynamic, the ways of scientific collaboration have grown in the last ten years as Luc mentioned in extracts 17 and 18.

5. CONCLUSIONS

Like the studies proposed by Chataway and Wield (2000), Garavelli et al (2002) and Prez-Bustamante (1999), we have shown that ICT is an essential element to improve the efficiency of the production of scientific knowledge by making it possible to access, manage, analyze, and disseminate information in a more agile and effective way by breaking the barriers of temporality and presence. Thus, the "electronic infrastructure" plays an essential role because it allows a shared access to different sources, infrastructures and materials independently of the geographical, institutional, and temporal location of the person who accesses it (Atkins et al., 2003; Candela, Castelli and Pagano, 2011).

Taking into account the contributions of Numprasertchay and Igel (2005), they note that research units in developing countries have many disadvantages compared to newly industrialized countries and developed countries in terms of knowledge, experts, researchers, and infrastructure. From the analysis presented, we can conclude that although developing countries have less technological infrastructures, it is the same digital technologies that allow to build access bridges to unstable and informal technologies and other absent infrastructures (based on the links of cooperation between scientists and barely formalized in agreements or regulated contracts). In this way, the existence of informal ties and digital technologies allow the barriers to access and production of knowledge to be broken. From this comes the need for a minimum of technology necessary to break down such barriers. Situations with a lack of infrastructure would not allow the establishment of technological bridges for the development of scientific research, limiting access to knowledge and scientific production.

Aguado-López and Vargas (2016) state that the dominant model of scientific communication implies a form of knowledge colonialism. In the case of access to knowledge, such colonialism is evident in the payment of prestigious digital publications (Harnad, 2001) due to the fact that they become difficult for institutions/professionals located in contexts of economic poverty, which increases this digital divide and barriers to access and production of knowledge.

In this line, Gaiza (2016) states that the publication model in high impact journals (mostly with editorial headquarters in Europe and the United States), has negative effects on the democratic dissemination of knowledge as it generates a barrier to access productions of those who do not have the institutional or personal resources to access them, as researchers, professors, students and society in general. This model is promoted by Latin American academic institutions in order to achieve higher institutional yields. "We are facing a vicious circle that privatizes the knowledge produced in our countries and a form of dependence that commercializes our intellectual resources and installs barriers to access the knowledge generated by ourselves" (Gaiza, 2016, 269-270)

In this way, in accordance with Tagler (1996), the limited access to scientific publications, exacerbated by the institution of copyright, can be a crucial element that limits the development of knowledge in Latin American countries. That is why the availability of institutions and scientists to the digital tools of the commercial and advanced research sectors (Atkins et al., 2003), becomes an imperative need for scientific and social development. Open Access is a potential scenario for the democratization of knowledge (Serrano Muñoz and Prats, 2005; Suber, P. 2015.)

In our research, we have observed how in these researchers' experiences in different universities in Latin America, there are different rhythms and access to digital technologies due to the great diversity and differences between the countries of this continent in respect to the scientific field. This diversity and differences are due to scientific policies, development of science and technology systems, and heterogeneous socio-economic contexts that are not coordinated by common institutional policies.

Despite having shown problems in each of the four points we have analyzed (creation of communication networks, search and accumulation of data, production of knowledge and competitiveness, dissemination of knowledge and visibility), fortunately there are solutions to solve these problems: Open Access (Babini, 2011 and Gainza, 2016) and research developed in transnational scientific networks are clear examples of this.

The strategies of Open Science, based on digital technologies (European Commission, 2016), can contribute to reducing the technological gaps in the access and production of knowledge and in scientific collaboration. The availability of publications, data, research prototypes and software (Kraker, P., et al, 2011) are elements of special relevance to promoting production and access to knowledge in an equitable way.

In the case of Open Access, it is a coherent strategy with open science proposals in the field of knowledge dissemination. Babini (2011) describes a clear growth of Open Access internationally and the construction of institutional repository networks in Latin America. Examples of this are "La Referencia" and "El Portal de Portales de Revistas de Latinoamérica y Caribe". Babini (2011) points out that these examples evidence a clear effort of the policies of Latin America and the Caribbean to guarantee Open Access to the scientific publications of the region. The author also highlights that the current increase of the support to Open Access at an international level (including European countries and the United States) could improve the access and scientific production conditions of researchers, breaking the access gap to international publications (Gaiza, 2016). These and other solutions should be promoted through public policies in order to create institutional collaboration bridges so that researchers from places with limited economic and technological resources are not isolated from the rest of the scientific community of the world.

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7. APPENDIX

The following is a conceptual diagram prepared by the ATLAS.ti tool.