



DIGITAL TRANSFORMATION AND HIGHER EDUCATION IN COLOMBIA: NEW SKILLS FOR NEW OPPORTUNITIES

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Abstract

This paper explores the challenge for digital transformation in Colombia, with the aim of evaluating HEI's initiatives and their effectiveness in educating youth with adequate skills, able to satisfy the emerging needs of the labour market and to boost innovation within companies. We explored the offer of university courses and programs aimed at developing different levels of digital competencies in the Colombian context, thanks to a data collection carried out with the web scraping technique. Results highlight great efforts in the country to align digital content learning with the needs of businesses and organizations. There is a rich offer in courses, adequately related to the different levels of digital literacy, but costs remain high, fueling the gap between social strata. Furthermore, the contents offered are often repetitive. Training strategies shared between different institutions could reduce costs in pursuing common digital education objectives and avoid a proliferation of much too similar courses. The originality of this work lies in the unified perspective regarding the analysis of the Colombian offer in digital training, which allows to highlight costs and overlapping of contents, suggesting network strategies, currently absent or weak, to create new shared paths of educational development.

Keywords

digital transformation; higher education; Colombia; digital skills; digital inequality.

1. Introduction

Digital transformation challenges concern higher education in the first place, which is responsible for training young people with the necessary skills, with the labour market coming in later, to promote job quality and to boost innovation within companies. The Colombian government has realized several initiatives to support the spread of information and communication technologies (ICTs), but other major changes and investments are needed to meet the challenge of digital transformation. The most changes arise in the educational field, thanks to high-skill training of students, who will be able to meet and satisfy the new growing needs of the digital market to take advantage of it as future workers and reduce social inequalities, which, in Colombia, are highlighted by the strong contrast between urban and rural areas (OECD, 2019a; Goldin and Katz, 2010). In Colombia, only half of the adults had an upper secondary education, compared to about three quarters in OECD countries. Thanks to PISA tests, which evaluate skills in 15-years-old students and thanks to mandatory upper secondary education, there have been many improvements in the last decade, but two thirds of students still lack basic literacy and numeracy skills, compared to a fifth of students in OECD countries. (OECD 2017a; 2017b; Radinger et al., 2018). To improve the skill level within the population, it is necessary to develop continuing education, since many adults leave education programs with low skills. At the same time, it is urgent to encourage and incentivize young people so that at least some of them will acquire high skills to be carriers of innovation. Nonetheless, emigration represents a great risk in this case: highly skilled graduates may prefer to emigrate to other countries where they are paid five times more than in their country (Observatorio TI, 2017; OECD 2017c).

Higher Education Institutions (HEIs) in Colombia are both public and private, and the quality of their learning programs is varied: only 6% ranks in the Latin America and Caribbean's (LAC) top 50 (according to Quacquarelli Simond's ranking), in line with other OECD countries, but there are also several "garage universities", which offer low-quality courses and gather socially disadvantaged students (Ferreya et al., 2017; OECD 2019b). For young people, the choice of university is complex due to lack of information. Recently, measures have been taken to disseminate information on the numerous educational opportunities given by university programs showing the results that were achieved, as well as the degree of employment for graduates, but only a few universities communicate adequately and effectively. In any case, students maintain high expectations for future earnings (Bonilla et al., 2017).

Digitalization involves loss of work for unskilled individuals, especially in the context of repetitive activities that can be easily automated (OECD, 2019c). The Pact for the Digital Transformation of Colombia aims to address exactly this problem (DNP, 2019), but there is still a lack of active labour market policies.

In this study, once the theme of digital transformation has been introduced, the second paragraph will show our literature analysis, centered on the challenges it poses, underlining the key role of education, since the development of digital skills brings advantages to those who possess them, but at the same time widens the gap compared to those who are not literate. Subsequently, in the third paragraph, we focus on the digital context in Colombia, where two factors emerge: the difficulty of accessing the Internet and the digital inequality between

different social strata. In the fourth paragraph, instead, we consider the offer of educational programs created by public institutions and the government to increase citizens' digital skills. In the fifth paragraph, we explain the methodology used to analyze the offer of the top ten Colombian universities with high quality accreditation, aimed at developing digital skills. In the sixth paragraph, we present and discuss the results of our research: the offer is rich and well-aligned with the needs related to the different levels of digital literacy, but it involves high costs. Finally, in the last paragraph, we reflect on the implications deriving from the findings: training costs represent a barrier for some social strata, exacerbating the divide. We conclude by suggesting the strategic importance of building networks to lower training costs and avoid overlapping of content.

2. Digital skills and educational systems

Digital literacy is defined in different ways, which from time to time emphasize certain aspects, such as ITU and the Digital Competence Framework for Citizens of the European Commission, known as DigComp (Antoninis and Montoya, 2018; Carretero et al., 2017). According to Law et al. (2018, p.6), it is defined as “the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship”.

Education plays an important role in the digitalization process and education systems must provide students with the appropriate skills (OCDE, 2020a). The European Commission, in its vision of digitalization, distinguishes 5 areas and 21 skills, such as information and data literacy, communication and cooperation, digital content creation, safety and problem-solving (Carretero et al., 2016). Furthermore, it also outlined the Digital Education Action Plan (2021-2027) as a call to action for cooperation between countries, proposing two strategic priorities: the development of a high-performance digital educational eco-system and the improvement of citizens' digital skills. It is a vision aimed at improving digital literacy, skills and abilities at all levels of education. In addition, the Dig Comp emphasizes that its actions involve the inclusion of AI and data-related skills, as well as the use of tools to invest in high-quality IT education. (European Commission, 2020a).

In recent years, education has increasingly required a creative and dynamic environment, where it is necessary to consider new educational standards to play a central role in the development of innovative pathways. Skills such as critical and creative thinking, empathy, ability to establish relationships, digital technologies are included in this new vision (della Volpe and Jaramillo-Gutiérrez, 2020; Mishra and Mehta, 2017; van Laar et al., 2017).

The pandemic has made the need for global educational itineraries to realign digital skills more urgent than a renewed and dramatically transformed job market because of Covid-19. Education 4.0 is being established: it requires digital and socio-emotional skills to foster innovation, automation of production and creation of intangible value (Schwab, 2019; UNESCO, 2020; WEF, 2020). A flexible education, within a holistic vision of human beings, where *hard skills*, such as data science, are combined with *soft skills*, such as cooperation and empathy, traces the way towards a more equitable and inclusive future.

Within companies, technological progress has highlighted the need for digital skills. While about ten years ago we talked about Machine Learning, in relation to the roles of software engineer, data engineer, project manager, today new roles are required, such as machine learning engineer, deep learning software engineer, mobile intelligence engineer, machine learning scientist, data scientist, machine language researcher (Cathles, 2020). In turn, WEF (2020) points out that the jobs of the future will be increasingly aligned with digitalization, as it happens for big data analytics, encryption and cyber security, AI, IoT, cloud computing.

These are sectors, that generate new job opportunities in the most technological profiles, which are reflected in prestigious careers and higher salaries (Gabriel, 2018).

On their part, companies consider digital skills as an ally, necessary to undertake competitive actions (Chi et al., 2010; Ravichandran, 2018). However, there is still a need to align knowledge areas of educational institutions, orienting them towards the needs that arise for the increasingly rapid and advanced development of industries (Gronau et al., 2017).

The need to collect data on the digital literacy of countries, as well as the identification of indicators to measure digital skills is shared by many, since they help to outline how each context is characterized (EQUALS, 2018; European Commission, 2016; Highet et al., 2017; ITU, 2017; World Wide Web Foundation, 2016).

According to ITU (2020), digital skills are divided into *basic*, *standard* and *advanced* levels. At a *basic* level there are activities such as: copying or moving a file or folder, sending emails with attachments, transferring files between a computer and other devices, using copy and paste tools to duplicate or move information within a document. At the *standard* level, there are skills such as: connecting and installing new devices, creating electronic presentations with appropriate software, searching, downloading, installing and configuring software, using a basic arithmetic formula in a spreadsheet. Finally, at the *advanced* level there is the writing of a computer program using a specialized programming language.

In fact, the European Commission (2020b) classifies digital skills according to DESI 2020 through five dimensions: connectivity, human capital, use of the Internet, integration of digital technology, digital public services.

Observing the regions of LAC, Katz and Callorda (2018) underline the difficulty of companies in adopting digital technologies, with a consequent negative impact in terms of productivity. Colombia is a country with a limited development of its digital ecosystem. LA is characterized by an entrepreneurial environment of micro and small businesses, where digitization has only recently emerged as a priority. However, the adoption of technological tools can have a positive impact on their productivity and competitiveness only if they are in line with government policies, creating alliances between global digital ecosystems, using adequate infrastructures and having appropriate digital knowledge (OECD et al., 2020).

The pandemic has generated changes in educational contexts around the world and has highlighted the urgency of developing skills to face the new digital challenges. The fastest response to Covid-19 in the world has been positively related to the overall level education and has suddenly shown inequalities in terms of connectivity and convenience, as well as the need to increase skills across the board. LA has managed to extend distance education to a large percentage of potential students, achieving better results than other regions of the world (91%), positioning itself above the world average (69%). The experience of the region has made it possible to generate a relatively positive impact in the transmission of lessons through digital media, but this media has been generated to a greater extent through radio (50%) and television (86%), recording greater potential for spread even in the most remote areas. To a lesser extent, ICT platforms have been used as alternatives to provide education through social networks and text messaging (UNESCO, 2020). Although digital platforms make an important contribution to education and economy, their inclusion requires appropriate conditions, such as a high connection speed and digital skills: in LA, their absence compromises their use (OECD et al., 2020). Due to Covid, the global context is adapting to a more digitized education using ICTs as a means of dissemination, so LA is also required to make changes in the educational context to aim for a broad digitization.

3. Shaping a Colombian digital society

Digital skills have become transversal skills, necessary in the educational context as well as in the labour market. However, the appropriation of this knowledge does not develop in the same way in all countries: there are digital gaps in terms of gender, age, level of education, position and income. The importance of reducing and eliminating initial barriers such as costs and access to digital technologies is clear (OECD et al., 2020).

In LA, less than 25% of adults used basic digital skills, particularly basic arithmetic formulas in a spreadsheet and less than 30% created electronic presentations with software, including text, images, sounds and videos. Furthermore, Colombia ranks well below high-income countries such as Luxembourg and Iceland, where over 50% of adults have used this type of digital skills. In addition, less than 20% of adults possess at least 7 of the 9 basic digital skills (UNESCO, 2020).

In relation to 15-year-old students, who belong to 25% of the poorest households in the country, less than 15% have Internet and a computer or at least 2 mobile phones at home and over 55% have no Internet or computer, or at least 2 mobile phones that allow students to participate in online lessons (UNESCO, 2020). These data, released before the pandemic, allow us to have an overview of the weaknesses to be addressed.

Regarding Internet access, only 20% of citizens in developing countries have this service, while in developed countries this figure is much higher (85%): which puts a country like Colombia at a disadvantage (UN, 2020). In 2019, 53.83% of Colombian households had access to the Internet, but only 26.3% of those with lower incomes, compared to 83.4% of those with higher incomes, revealing a digitization gap linked to social stratification (MinTic, 2019). At school level in LA countries, all students who have access to computers in schools do not necessarily use them: about 25% of students in the region, who have access to technological infrastructures, do not use them. In Colombia they are only 10%, which is the best indicator among the LA countries. Furthermore, in the country, about 80% of 15-year-old students have access to a computer, a value below the LA (85%) and OECD average (95%). 80% of 15-year-old students use computers, a value above the average of LA (70%) but lower than OECD (85%). Finally, 80% of students have access to the Internet, a value below the average of LA (95%) and OECD (95%).

Colombian 15-year-old students with socio-economic privileges have access to ICT in schools, both computers and the Internet (95%), ranking above the LA (80%) and OECD average (85%). On the contrary, only about 65% of students with socio-economic disadvantages can access ICTs through their school, a figure above the LA average (55%), and much lower than the OECD average (80%). Socio-economic aspects play an important role in student access to technology in the region: schools serve as Internet providers for more than 20% of rural students who do not have access from home, but can connect online in their schools (OECD, 2020b).

For its part, Colombia has made progress in terms of forming an inclusive digital society. The number of students per computer fell from 1.6 in 2015 to 1.1 in 2018, in line with the OECD average (from 1.8 in 2015 to 1.1 in 2018) and below the LAC average (from 2.4 in 2015 to 1.6 in 2018) (OECD et al., 2020).

However, in LAC, the higher education system is characterized by fragmentation and diversification, with a prevalence of private HEIs over public ones (Katz, 2018). There are a total of 361 universities in Colombia, of which 67.7% belong to the private sector (SNIES, 2021). Furthermore, in the region, degrees are issued after 5 years, while in other regions they are issued after 3 or 4 years. Degree courses in other regions are more flexible in absorbing new contents, which allows them to be more labour market oriented and to assimilate changes in disciplines, based on the needs of society and the economy (Katz, 2018).

4. Educational plans for digitization in Colombia

Colombia has identified ICT as an object of public policy since 2000, with the Conpes 3072 *Connectivity Agenda* document which sought to standardize ICT and improve the competitive conditions of the productive sector, modernize public and government institutions, socialize access to information according to the 1998-2002 National Development Plan *Change to build peace* (UNESCO, 2000). Subsequently, in 2009, it created the Fund for Information and Communication Technologies (FONTIC), which strengthens the initiative for the development of government policies in line with the achievement of the digitization of citizenship. By 2021 FONTIC has planned to invest in national projects related to the implementation of community access solutions to ICT, strengthening the digital transformation of companies, the generation of policies and strategies aimed at improving the competitiveness of the communication industry and the development in the massification of Internet access nationwide (MinTic, 2020a).

On the other hand, the national government has encouraged digital skills training with several strategic plans. The *Live Digital Plan* (2010-2014), implemented by the Ministry of Information and Communication Technologies (MinTic) and the National Planning Department (DNP), sought to spread the Internet to reduce unemployment and increase competitiveness in rural areas. Subsequently, in 2014-2018, the *Live Digital Plan for people* followed, aimed at encouraging the development and use of smartphone applications (DNP, 2018). Currently, the 2018-2022 ICT Plan *The digital future belongs to everyone* aims at the digital inclusion of citizens, access to the Internet for 100% of Colombians and the implementation of more efficient connectivity programs (MinTic, 2018).

At the same time, training activities are promoted to improve citizens' educational skills: the *Computers to educate* program of 2000 provided the educational locations of computers and tablets (MinTic, 2020b). The 2011 *Digital citizenship* strategy was recognized by ITU in the Wsis Prizes 2018 Awards: it aims to certify digital skills and competences with courses from 10 to 48 virtual hours for all those over 13 years of age (MinTic, 2021). *Mission TIC 2022* aims to train young people over the age of 15 in programming, digital technologies and creative industries (MinTic, 2020c).

In addition, programs for entrepreneurs are promoted, such as the *Business Digital Transformation Centers* initiative in alliance with MinTic, INNpulsA and the Chambers of Commerce, which offers support to entrepreneurs (Centros de transformación digital, 2021). The *Digital entrepreneur* program certifies entrepreneurs, SME collaborators in the fields of e-commerce, digital marketing, virtual monetization, strategic planning (Empresario digital, 2021).

Finally, being part of the Colombian education system, the *Nacional Learning Service* (SENA) offers post-secondary continuing education free of charge to Colombians. In 2021 he promoted learning paths in Python and predictive analysis, cybersecurity, IoT. It has also included alliances with technology leaders such as AWS Educate and LinkedIn Learning, which offer students complementary certifications (SENA, 2020).

5. Research methodology

The aim of our research was to identify educational programs, focused on digital skills, among those offered by Colombian universities: a dataset was created for this purpose by consulting the universities' official websites. First, we selected the keywords, such as "digital

skills”, “Excel”, “programming”, “data”, “technology” and “software”, then we analyzed the university courses provided for students and the community.

All data has been collected during March 2021. The 10 best high quality accredited Colombian universities were considered for this work. Accreditation is defined as a voluntary process, whereby an institution or academic program undergoes an evaluation and is recognized for “the quality of its programs, its organization and functioning and the fulfillment of its social function” (MinEducación, 2013, p. 47). Of the 361 public and private universities that exist today in Colombia, only 90 have achieved high quality accreditation (SNIES, 2021) and most of these are private (56 compared to 24 public ones).

To determine the target universities of our research, we took into consideration the U-Sapiens 2020 ranking for Colombia, which ranks the best universities basing on the following research indicators: journals indexed in the Publindex national bibliographic index, masters or active doctorates and research groups recognized by MinCiencias (Sapiens Research, 2021). We chose the top 10 universities in the ranking, taking into consideration only programs and activities carried out in their main venue, which, in our case, coincides with the accredited center.

Data analysis started with the creation of a dataset, including 11 variables: ranking, name of the university, city, department of afference, program offered, duration in hours, level of competence at the end of the program, objective, cost, provision modes and possible alliances. We have not considered either the semester or the degree course. Then, we converted the dataset into a database for the interpretation of results.

The *web scraping* technique was used to extract information from websites. Subsequently, these data were imported into our database to proceed with their analysis (Sirisuriya, 2015). This process allows the transformation of unstructured raw data into structured data, having human intervention that guarantees its accuracy.

6. Data analysis

The top 10 universities in Colombia’s U-Sapiens 2020 ranking (having high-quality accreditation by the National Accreditation Board - CNA- in March 2021) were included in our dataset for the analysis. Specifically, we considered: University of Antioquia in Medellín, University of Valle in Cali, Pontifical Javeriana University in Bogotá, Industrial University of Santander in Bucaramanga, Pontifical Bolivarian University in Medellín, University of the North in Barranquilla, Pedagogical and Technological University of Colombia in Tunja, University of the Andes in Bogotá, University of Caldas in Manizales and Technological University of Pereira. Among these, 6 are public universities and 4 belong to the private sector. In fact, 6 of the 10 universities considered participate in the government program *ICT Mission 2022*: University of Antioquia, University of Caldas, University of the North, Industrial University of Santander, Pontifical Bolivarian University and Technological University of Pereira.

A total of 57 digital skills related programs was provided by the analyzed universities in March 2021, focusing on different approaches: program management (13), cyber security (2), data analysis (15), Excel tools management (10), programming (17). These programs are offered as courses (85.96%), MOOCs (8.77%), free choice courses (3.51%) and diploma courses (1.75%).

Next, we analyzed the courses offered considering the level of digital skills they intend to develop: the 43.86% sets to the *intermediate* level, 42.10% to the *advanced* level and 14.04% to the *basic* level. As for the *basic* level, 75% of the courses are program management related, while the remaining 25% refers to cyber security. Focusing on program management, the HEIs

offer, for example, the courses *Digital Skills within the European Union* and *Science, Technology and Gender* at the University of the North; the course *Basic Programs* at the University of the Andes; the course *Digital content for the generation of the brand value* at the Pontifical Bolivarian University. As for the topic of cyber security, the Pontifical Javeriana University offers the MOOC *Protection of personal data* and the University of the North provides *Cyber ethics*.

At the *intermediate* level, data analysis programs account for 50% of the total, Excel tools management represent 37.5%, programming is the 8.33% and program management sets at 4.17%. Data analysis programs are offered largely at the Pontifical Javeriana University (6), such as, for example, courses in *Statistics with R*, *Data Analysis*, *Information Analysis supported by statistical and geographic software*. The University of the North delivers courses such as *R Study* and *Introduction to Data Science and Machine Learning*; the Industrial University of Santander offers courses in *Data Analysis for Business and Database* or *Big Data*. The University of the Andes provides the course *Introduction to Data Analysis in R*. Regarding the management of the Excel tools, the Pontifical Bolivarian University offers the courses *Automation of processes with Excel macros* and *Intermediate Excel*; the Pedagogical and Technological University of Colombia provides *Excel for Productivity* and *Intermediate Excel*; the Technological University of Pereira offers the course *Excel for the generation of reports*; the University of Valle provides the program *Excel with an emphasis on administration and Data Analysis*; the University of Antioquia offers the course *Skills in managing Microsoft Excel spreadsheets*. As regards programming, the University of the Andes provides the MOOCs *Introduction to Web Development* and *Introduction to Object Oriented Programming in Java*.

Considering the *advanced* level, 60% of programs deal with programming, 24% with program management, 12% with data analysis and 4% with the Excel tools use. As for programming, different courses are provided, such as: *Cyberops Associate*, *Linux Essentials*, *CCNA Security*, *CCNA 7.0* (Technological University of Pereira); *Programming tools for data analysis and MOOC programming in Python* and *Introduction to Unified Modeling Language* (University of the Andes); *Business Intelligence with Python* (University of Antioquia). On the topic of application management, we find *Application development with Blockchain and Illustrator* (Pontifical Bolivarian University); *Microsoft Project Professional 2016 basic and advanced* (University of the North); *Microsoft Power BI* and *Microsoft Project Applications for project management* (Pontifical Javeriana University). In conclusion, focusing on data analysis: *Business Analytics* and *Data Mining in R* (Pontifical Bolivarian University); *Access to structured data for analysis with SQL* (Pontifical Javeriana University).

The alliances developed between the universities and other institutions issue certificates on behalf of the two partner institutions. Regarding the courses related to digital skills, 70.18% of HEIs did not generate any alliance; 10.53% did it with MinTic (with programs such as *ICT Mission 2022*); 7.02% did it with the Cisco Networking Academy Program (Technological University), 10.53% did it with Coursera thanks to the Coursera for Campus program and the MOOCs (Technological University of Colombia, University of Caldas and University of the Andes); 1.75% with the Sumanti Educational Fund (Pontifical Bolivarian University). The universities that offer most of the partnership programs are the Technological University of Pereira (6 programs) and the University of the Andes (4 programs). In contrast, University of Valle, the Pontifical Javeriana University and Pedagogical and Technological University of Colombia have no partners.

Focusing on the costs of these programs, we observe that they vary according to the city, the duration in hours, the university and the type of course. 38.6% of the courses cost between USD 150 and USD 300; 21.05% cost less than USD 150; 14.04% cost above 300 USD. Only 19.3% of the courses is free and 7.02% is included in tuition for undergraduate programs. In particular, the free courses are provided in alliance with MinTic and Coursera's MOOC.

7. Conclusions

Digital skills represent a key element for accessing the labour market in the coming years (WEF, 2020) and their inclusion as a transversal training at all educational levels is urgently needed. Only in this way it is possible to develop more advanced digital skills and respond to a labour market that increasingly requires these skills.

In recent years, in Colombia, the offer of courses aimed at increasing levels of digital competence has often been extended to the entire community, with the aim of reaching all citizens. However, these plans consider ambitious goals while the access, use and training of tools that enable high levels of digitization among citizens are still limited (MinTic, 2021; World Bank, 2020). Therefore, they generally end up fueling large inequality between social strata, as well as between rural and urban areas.

As we have seen through our research, higher education in Colombia is characterized by a great diversity in courses, offered to a greater extent by private institutions. This makes it difficult to generate common strategies that respond to a general educational development matrix, focused on the formation of human capital, for the benefit of the entire country.

The labour market has an urgent need for digital skills to introduce innovation, it requires resources trained in technological and digital disciplines at all educational levels and from all areas of knowledge, but in Colombia the HEIs offer transversal courses based on individual initiatives, which do not respond to the development needs of the whole country. Thus, the proposed activities often overlap and generate confusion in the choice by the recipients. The courses offered by universities are still part of a complementary training, even for those who are currently amid their university studies. In this way, access to this indispensable training remains open only to the highest social strata, generating further inequality.

Finally, universities offer digital skills programs individually, without the support of institutional alliances (della Volpe, 2018), that could strengthen and complement their offer. The few and isolated alliances that are made do not translate into obvious benefits for students or citizens and are limited to the provision of a certification endorsed by the institutions in partnership. Alliances and networks could be cultivated to provide more obvious benefits to students, which translate into economic benefits. These alliances could be the starting connections from which to proceed to create networks within the educational ecosystem. For universities, belonging to a network means entering a wider educational system, in which cooperation with institutions and companies is fundamental. Being nodes of a network means sharing common goals by strengthening one's position. This process of building meaningful alliances could prove to be an important strategy to consolidate each actor in the network, as long as it is carried out on the solid foundations of collaboration between different subjects, communication, trust and mutual exchange.

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