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Digital transformation, skills and education: A systematic literature review

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Abstract

Digital transformation (DT) is raising new challenges. This article seeks to understand how DT has changed business strategies, requiring a new profile of professionals, analyzing the most sought-after skills and identifying opportunities for future professionals. Also, it studies whether universities have incorporated in their training the new skills required by the labor market impacted by DT. To these ends, a systematic literature review dealing with digital transformation, competence, and education was conducted. The existing literature was categorized into seven main areas of investigation: digital literacy; skills identification; use of digital technologies in teaching; learning models; workforce qualification or re-skilling; digital technologies in the labor market; and undergraduate course analysis. This structuring then lays the groundwork for capturing gaps in the literature and proposing future research.

Keywords

Digital transformation, digital technologies, competencies, education, systematic literature review

Introduction

Digital Transformation may be understood as referring to the integration of digital technologies into business models and business processes (Hess et al., 2016; Liu et al., 2011). Digital technologies include social media, artificial intelligence, analytics, or embedded devices. One of the goals of that integration is to create value and generate revenue from digital assets (Bharadwaj et al., 2013; McDonald and Rowsell-Jones, 2012), encompassing intellectual property, digital media, data and information, online platforms, and websites. Having occurred throughout the 21st century, Digital Transformation is characterized by the merging of cyber-physical systems, the Internet, the Internet of Things (IoT), industrial integration (Xu et al., 2016), industrial information integration (Xu, 2020), as well as the growth in the use of artificial intelligence, cloud computing, robotics, 3D printing, data science, and advanced wireless technologies (Xu et al., 2018).

As Amit and Zott (2012) note, the digital future, which is increasingly shaped by digital technologies and the digitalization of various aspects of life and business, presents new opportunities and challenges for organizations and requires a new type of employee that can work in unstructured and unpredictable circumstances. Given the expected changes in occupations, the demand for new and different skills is bound to increase. Higher education is vital in generating skills (Kurbanov et al., 2020). Even if preparing students for the labor market is not the sole role of higher education (Barnett, 1994; Bergan and Damian, 2010; Chur, 2011; Klemenčič, 2010), it seems critical that higher education institutions (HEIs) adjust and anticipate the new skill-sets demanded in the labor market (Pineda-Herrero et al., 2018). However, up to now, there seems to be a gap between what the market sees as relevant and what HEIs have offered (Goulart et al., 2021).

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The purpose of this research is twofold. First, in the wake of the digital transformation, to systematize extant research on the most sought-after skills and opportunities for future professionals. Second, to systematize extant research on whether universities have incorporated the new competencies required by the labor market into their training.

To meet these goals, a systematic literature review was conducted of 87 articles in the *Web of Science* and *Scopus databases* dealing with digital transformation, skills, and education in internationally known academic journals in English.

We develop a conceptual framework that summarizes the relevant personal skills and competencies in the context of digital transformation and that clarifies how new digital technologies have impacted undergraduate courses. The proposed framework has practical applications for professionals, business organizations, and universities. First, it provides professionals with a roadmap to align their skills and competencies with the needs of the labor market. Second, it helps companies realize how digital transformation demands skilled professionals to successfully implement digital strategies, i.e., the organizational initiatives and actions undertaken to leverage digital technologies and capabilities to achieve business objectives. Third, it can assist universities wishing to adapt their product-mix to provide the skills and qualities demanded.

The article begins by presenting the concepts of digital transformation, competencies for digital transformation, and education for digital transformation. Next, the methodology and the literature selection process adopted are presented. This study seeks a content analysis of the articles. Then, the research results are presented, and finally, the conclusions.

Literature review

Digital transformation

Vial (2019, p. 118) argues that digital transformation is a multidimensional, technology-driven phenomenon impacting society, politics, and the economy. He defines it as "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies".

One of the dimensions of digital transformation is the offering of new products and services, enabling the creation of *new* business models. Nambisan et al. (2017, p.224) thus characterize digital transformation as "the creation of, and consequently change in, market offerings, business processes, or models that result from the use of digital technology". Another noteworthy dimension refers to *changes* in business strategies. Digital transformation within the firm is a specific type of strategic change (Klarner and Raisch, 2013; Rajagopalan and Spreitzer, 1997), because it alters a company's value creation and may alter its purpose (Hess et al., 2016). Finally, the changes in processes brought by digital transformation are highlighted by many authors. As per Downes and Nunes (2013) and Matt et al. (2015) Digital Transformation goes beyond the simple digitization of resources and involves the transformation of core operations, products, and business processes, culminating in revised or entirely new business models.

Skills for digital transformation

According to Kohnke (2017), three primary requirements must be met by companies for a successful digital transformation: new skills and competencies (e.g., digital skills), different organizational capabilities, and different forms of leadership (e.g., digital vision).

Skills and competencies may be classified in many ways. Skills can be defined in terms of cognitive factors (e.g., different types of knowledge), perceptual and intellectual motor skills (e.g., dexterity), affective factors (e.g., attitudes, values, motivation, etc.), personality traits (e.g., self-confidence), and social skills (e.g., communication and cooperative skills) (Ellstrom and Kock, 2009). In their turn, Hecklau et al. (2017) classify competencies into four categories: technical knowledge, methodological, social and personal skills. Others focus on the type and composition of skills, dividing them into *hard skills,* which include technical skills, aptitudes, knowledge, and abilities that the individual needs to perform his or her job, and *soft skills,* which refer to personal and behavioral skills (traits, character, attitudes, motives) (Robles, 2012; Woodruff, 1991).

What it means to be digitally competent is far from clear. Usually, competencies can be described in terms of knowledge, skills, and attitudes, which can be hierarchically organized (Cheetham and Chivers, 2005). However, when it comes to digital competence, current definitions vary depending on the context and specific language used, digital literacy, *e-skills,* information literacy, and media literacy (Ala-Mutka, 2011) resulting in a "jungle of jargon" (Ferrari et al., 2012).

Several authors (Ala-Mutka, 2011; Eshet-Alkalai, 2004; Eshet-Alkalai and Chajut, 2010; Ferrari, 2012; Martin, 2006) have attempted to develop the concept of digital skills, defining the components and elements it includes. They seek to enable an assessment or measurement of skills and abilities and improve the understanding and development of digital competence in society.

Education for digital transformation

As digital technologies enable new forms of automation (Neumeier et al., 2017) and decision-making processes (Dremel et al., 2017; Hess et al., 2016), questions about the need to develop the skills of existing workers (Hess et al., 2016)

as well as the skills needed in future workers (Colbert et al., 2016) are also becoming increasingly relevant (Watson, 2017).

In the literature, the concept of employability is presented with various definitions associated with the skills and qualifications of the individual. However, it invariably involves an individual's ability to obtain employment (Brown et al., 2003; Harvey, 2001; Yorke, 2006). This ability reflects, inter alia, the possession of competencies (*hard* or *soft skills*) that can be demonstrated in the performance and results in a work context.

To meet the challenges of competitive markets, higher education is expected to produce graduates that meet the needs of firms (Bridgstock, 2009; Barth et al., 2007). There seems to be a consensus on the need to bring higher education and employers closer together to align curricula with labor market needs (Boden and Nedeva, 2010; Crebert et al., 2004; Kumar and Jain, 2010) and to promote partnerships and protocols to promote and plan professional internships (Lowden et al., 2011; Harvey, 1999). True to this, Nagarajan and Edwards (2015, p. 26) add that the development of professional skills is "a distributed responsibility".

Many authors offer practical recommendations for HEIs. Sieber (2017) suggests that rigid structures, based on content matrices, with mandatory and equal requirements for all students, should give way to models allowing learners to create their portfolios and learning trajectory. Pacheco et al. (2020) propose a series of recommendations aimed at transforming educational institutions in three key aspects. Firstly, they advocate for a shift from traditional teaching methods to embrace digital education, disrupting the conventional analog approach. Secondly, they encourage internal reviews of how courses are structured and delivered within the educational sector. Lastly, they address the potential challenges posed by external factors such as legal frameworks, rules, and regulations governing the sector.

Methodology

This paper conducts a systematic review of the literature that relates to digital transformation, skills, and education. According to Greenhalgh (1997), a systematic review can be understood as an overview of primary studies that contains an explicit statement of objectives and methods and that is conducted according to an explicit and reproducible methodology.

The literature selection process consisted of the phases indicated in Figure 1. Each phase aimed to refine the number of articles according to predefined criteria.

Results

The temporal distribution of publications shows us that the total publications in the period from 2018 to 2022 show the largest variation between the year 2018 with 11 publications and the year 2019 with 32 publications. Not considering the year 2022 as it was still in progress.

Regarding the temporal distribution of citations, we can observe a large number of citations in 2021. However, this effect occurs because a single article had many citations this year, 116 citations. These movements can be observed by analyzing Figure 2.

Regarding citations, the articles in the sample received 586 citations with an average citation rate of 6.73 and a standard deviation of 16.72. The coefficient of variation (quotient between the standard deviation and the mean) of the data shows a value of 248%, indicating a large dispersion among the citation numbers, which can be explained by the large citation volume of a single article. In addition, 25.29% of the articles were not cited at all; 49.42% were cited 1 to 5 times; 8.05% received between 6 and 10 citations, and 17.24% obtained more than 10 citations.

Content analysis

After carefully analyzing the articles that make up this database of studies, we extracted relevant data, analyzing the keywords, type of research, objectives and conclusions of each article. Thus, we were able to identify themes and categories. We then conducted an analysis of the clusters formed to see if the grouping would allow an organized analysis and conclusions on specific topics. As a result, we identified 7 distinct groups according to their main contributions: (i) *digital literacy;* (ii) *identification of competencies*; (iii) *use of digital technologies in teaching*; (iv) *learning models;* (v) *qualification or requalification of the labor force;* (vi) *digital technologies in the labor market*; (vii) *analysis of undergraduate courses.* In the appendix, there are tables with articles separated by groups.

Group 1: Digital literacy (N=11)

In this group, the studies look at digital literacy and its importance in light of the digital transformation in society. According to the Council of the European Union (2018, p. 9), "digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for education, work, and participation in society".

A very relevant theme is how digital literacy impacts society. Digital literacy can impact social inequality, and it is advisable to promote the use of ICT in disadvantaged groups to reduce social inequality (Zilian and Zilian, 2020). This aspect can be evidenced when Hidalgo et al. (2020) demonstrate that the level of digital literacy is related to the level of socioeconomic status of the individual. While Sait and Anshari (2021) state that digital literacy is crucial for the country's economic development in the digital economy.

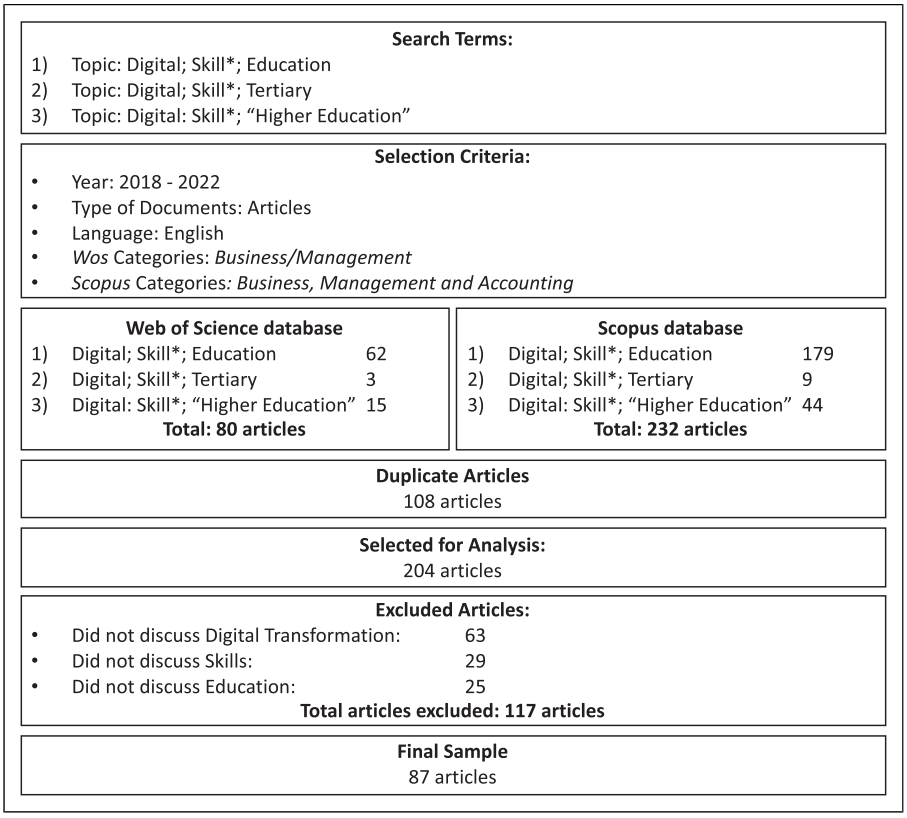

Figure 1. The stages of the systematic search process.

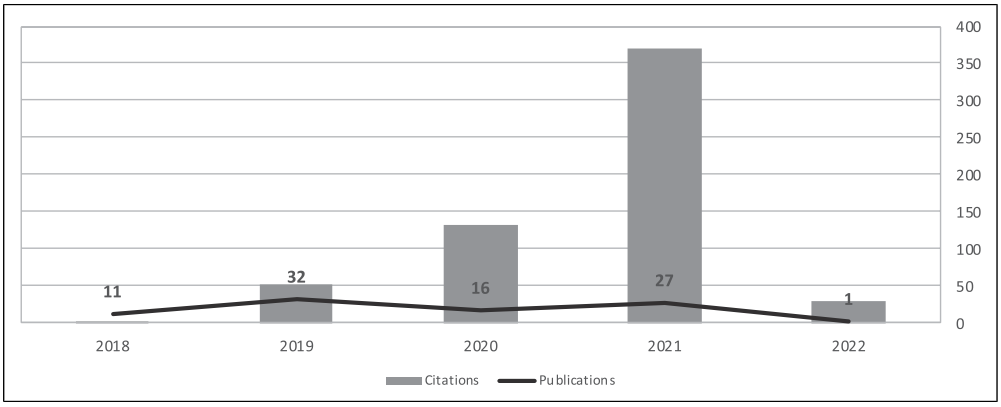

Figure 2. Time distribution of publications and citations.

Measuring the level of social literacy is discussed in several articles. In the area of education, Tetep and Suparman (2019) measure the level of media literacy of undergraduate students. While Kaarakainen (2019) and Rahim (2019) study high school students. Teachers are also assessed, indicating that the teacher literacy process is still at an early stage (Hidayati et al., 2020) demonstrating that digital skills and competencies will be important in building new learning scenarios (Tejedor et al., 2020; Tewari and Birla, 2018).

Regarding organizations, managers' digital literacy level is an important factor for success in digital transformation, since only with proper knowledge can managers make strategic decisions for the organization (Bolek et al., 2018). However, organizations need to develop models for measuring the level of employees' digital literacy (Cetindamar et al., 2021).

Despite the importance of digital literacy in the digital economy, no contribution offers a framework for a collective effort to improve digital literacy, but only actions taken individually. An important aspect that the literature cannot determine is whether there are intangible sociocultural factors that shape ICT usage behavior across different countries.

Group 2: Identification of competencies (N=16)

In this group, the studies work on identifying the individual competencies required by the digital transformation.

New competencies are required from professionals so that they can act in this digital transformation scenario. The identification of these new competencies is a theme present in several articles. We have identified the following sectors:

- the retail sector, where social skills are important if the potential of new technologies is to be fully understood and utilized (Woods et al., 2021);
- accounting, where future accountants need to be able to understand the uses and limitations of digital technologies in business in a broad context and not just limited to the accounting function (Tsiligiris and Bowyer, 2021);
- data analysis, when it concludes that in Russia the demand is more for hard skills, while in the US the demand is more for soft skills (Skhvediani et al., 2021);
- law, which concludes that the legal workforce must develop knowledge in other areas (e.g. digital technology and design thinking) in addition to legal knowledge (Janeček et al., 2021);
- library science, when it was concluded that library science courses need to update their menus so that graduates have the necessary skills to work with new technologies (Ascoli and Galindo, 2021);
- industry, which identifies cognitive skills as the most important for human capital, followed by emotional and behavioral skills (Singh et al., 2021; Spöttl and Windelband, 2021).

Marketing was the area with the most articles that seek to identify competencies. One of the important aspects is whether graduates are leaving their training with the competencies that the market demands, specifically with the competencies needed to work with digital marketing (Elhajjar, 2022; García Martín and Echegaray, 2019) and how universities are adapting themselves to teach these new competencies (Kurtzke and Setkute, 2021).

This said, those who are already in the market also need to have these new skills. Echegaray and Martin (2019) show that six of the top 10 skills required by the market are related to the digitalization process. While Di Gregorio et al. (2019) identify five categories of employability skills: basic social skills, analytical skills, digital and technical skills, procurement skills and customer perception skills.

In addition to impacted sectors, functions also need to adapt to the new reality. Kurmanov et al. (2021) and Philip and Gavrilova Aguilar (2021) identify the skills that managers need to lead the organization in digital transformation. Entrepreneurs are also impacted: Harding et al. (2020) analyze the skills for entrepreneurship in the digital age and conclude that it is necessary to provide more training in the technology area. For organizations to be able to innovate, Wodarski et al. (2019) consider that it is essential to develop knowledge, skills and attitudes related mainly to cognitive, social, interpersonal and innovative skills for graduates to succeed in the innovation process.

Although the articles assess the skills that the market is demanding, one issue that could be studied is the assessment of the return on investment by governments and the students themselves in cases where educational programs do not match the structure of the skills demanded in the market.

Group 3: Use of Digital technologies in teaching (N=12)

In this group, the studies work on the use of digital technologies in the education system. This refers to several phenomena, such as the development of e-learning, equipping institutions with software, or introducing artificial intelligence into the educational process and applying digital tools and resources in various educational contexts, including classrooms, remote learning, and virtual environments.

The education sector is changing as a result of digital transformation through the adoption of new technologies, but for this to occur, educators must be at the forefront of this process (Crittenden et al., 2019; Iivari et al., 2020). One of the first technologies that the industry adopted was the e-learning system. With the challenges raised by the Covid-19 pandemic, the use of this kind of technology was deepened by the need for online classes. Still, its application requires the qualification and adaptation of teachers (Stewart and Khan, 2021; Webb, 2021).

The adoption of new technological tools allows the emergence and use of new modes of education, MOOCs (*Massive Open Online Courses*) is a form of education that can be used in various contexts and for various purposes, whether for the teaching of students in various areas (Goglio and Bertolini, 2021) or even for the training of teachers (Sharov et al., 2019). Faridi and Ebad (2018) consider that the increased use of MOOCs will require universities to adapt and accept them as certification tools.

Social media can also be used for teaching. López-Carril et al. (2020) demonstrate how *Linkedin* can be used in

teaching sports management, while Low and Wong (2021) investigate the use of *Facebook* by engineering students. In addition to social networking, other technology tools are being used, Abdurahimovna (2021) analyzes the use of communication technology tools in learning to model clothing, which allows the adoption of a project-based teaching methodology.

The changes generated in the education system by the adoption of new technologies will require their use to be evaluated by stakeholders, to understand how students are reacting to this change (Vizo et al., 2020) or to measure the impact of the changes on education indicators, thus being able to identify best practices and support states in adopting new education policies (Cosmulese et al., 2019).

The section presented examples of adopting digital technologies in education but emphasized that educators must be prepared and stimulated to work with the new learning elements for the best implementation of digital tools. In addition, everyone involved in the educational process must be aware of the differences between the traditional way of delivery, the new ways of teaching, and the changes needed to support structures and processes when adopting digital technologies in education. Future studies may evaluate the use of digital platforms that explore the development of digital educational provision, and consequent improvement of the qualification of teachers, scientists and students.

Group 4: Learning model (N=18)

In this group, the studies work on new learning models in light of digital transformation. A learning model involves a combination of mechanisms and activities for acquiring new skills and knowledge to encourage and facilitate learning.

Habanik et al. (2019) state that knowledge can quickly become obsolete with technology changing so fast that traditional learning will no longer be effective, and the education system needs changes. As such, León et al. (2018) present the *T-based* model, which consists of training with 75% based on acquiring technical knowledge and 25% based on acquiring knowledge in innovation and entrepreneurship. In the same vein, Melnyk et al. (2021) reveal that a person needs to acquire new knowledge and skills in the shortest possible time and, to achieve this goal, the use of digital modeling and other disruptive technologies is required. Finally, the demand from new generations requires that new methods be applied, using the innovations generated by digitalization in teaching (Marie and Kaur, 2020).

The new skills demanded by the market and the use of digital tools make it necessary to revise curricula to better train students for the digital economy, such as the knowledge to work with Big Data (Grenčíková et al., 2021). While, Ilori and Ajagunna (2020) argue that implementing STEAM Education, i.e. focusing on science, technology, engineering, arts and mathematics subjects, regardless of the context, will be critical for everyone. Li (2020) already proposes a curriculum structure based on systems thinking, that is, having the ability to understand facts not only in themselves but also in other people and instances involved in the situation.

Various learning models are being put in place as a result of digital transformation. Rohm et al. (2021) Discuss project-based learning in another article, Rohm et al. (2019) analyze this methodology in marketing courses. Learning through business games also benefits from technological innovations and enhances the attainment of the new skills required (Bashynska et al., 2019). Kemp et al. (2019) evaluate the use of the *Matchmaking* technique as a facilitator of student learning. However, other methodologies are evaluated, Rohman et al. (2020) verify the impact of implementing project-based, technology-based, active learning in physics (PROTECTIVE), while Moldoveanu and Narayandas (2019) describe how the PLC (*personal learning cloud*) is making it possible to measure skill acquisition. For these new methodologies to be successfully implemented, Vinogradova et al. (2019) advocate the introduction of SMART education, which is a methodology that establishes criteria, which are specific, measurable, achievable, realistic and time-bound, thus enabling the monitoring of implemented actions.

For the efficacious introduction of these new learning models, the teaching environment needs to be rethought, with changes to the design of the teaching environment (Van Den Berg, 2019), the existence of classrooms with available technologies will be necessary (Tarabasz et al., 2018). The educational processes will also need to change, with the opportunity to outsource some educational processes emerging (Kurilova et al., 2019). However, Kisa (2019) argues that all these changes alter the processes of the various players in the educational process, such as educational policymakers, teachers, and students.

Group 5: Labor qualification or requalification (N=13)

In this group, the studies work on the qualification or retraining of the workforce in light of the digital transformation. They explore how companies perceive the impact of digital technologies on the education and training needs of current and future employees.

For organizations to successfully implement digital strategies, the workforce needs to be qualified with the essential skills for the new business model (Cardenas-Navia and Fitzgerald, 2019). Several business sectors are demanding new skills from future employees, ranging from sectors such as IT, where a positive relationship between IT

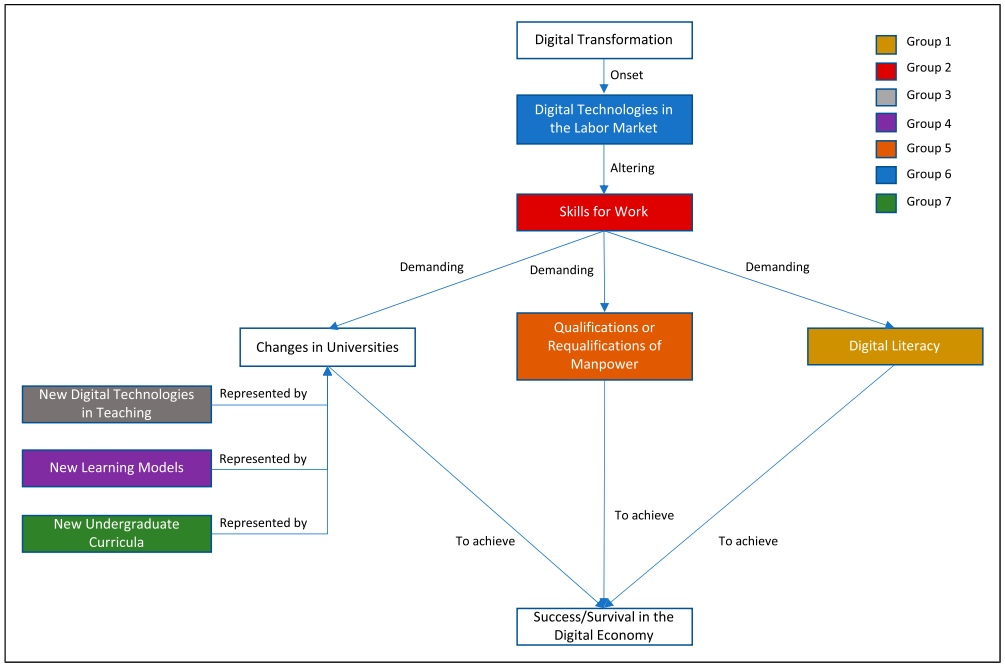

Figure 3. Main issues in literature.

skills and employment has been demonstrated (Atasoy et al., 2021), hospitality and tourism, where digital skills will enable the implementation of innovations in the area. (Adeyinka-Ojo et al., 2020), mining engineering, which is important for increasing the productivity and efficiency of mining companies' activities. (Alvarez et al., 2019), civil engineering, which would propitiate the implementation of new working methods, and civil construction, which would propitiate the implementation of new working methods. (Ibrahim et al., 2019), in France, industrial electronics, which established a partnership with the academic area to capacitate the sector's employees with the new skills required (Bonnaud, 2021) and entrepreneurship, where it was demonstrated that spaces focused on the development of entrepreneurship can promote 21st-century skills. (Rayna and Striukova, 2021).

The workforce that is already within organizations also needs to adapt to this new scenario, thus organizations need to invest in retraining these employees. Achtenhagen and Achtenhagen (2019) conclude that retraining the organization's employees is important for the decision to implement digital technologies. For this requalification to occur, Cascio (2019) states that the human resources training and development sector needs to adapt to provide the qualifications required by the market. Regarding the vision of the employees, Kar et al. (2021) analyze the employee's behavior for the requalification process. The education sector also has to requalify itself to be qualified for the new market needs (Suhasini and Santhosh Kumar, 2019).

A theme discussed by Perkins and Pryor (2021) and Cowley et al. (2021) is the use of digital credentials to certify that the professional has acquired professional competence.

Group 6: Digital technologies in the labor market (N=6)

In this group, the studies work on the impact of the adoption of technologies in the labor market, both for organizations and employees.

With digital transformation, various digital technologies have been adopted by the market, causing impacts and changes in society, due to the need for new skills for the labor market (Vassiliadis and Hilpert, 2020) and in jobs, especially with the introduction of robots in various sectors of the economy (Marin, 2018). Barna and Epure (2020) discuss youth unemployment because they are not qualified to work with the new technologies. For this problem not to occur, Dyatlov et al. (2018) argue that public or private investment in human capital should be a strategy adopted by countries. While Foerster-Pastor and Golowko (2018) they analyze what skills the IT sector requires from employees to be employable. The regional innovation systems have to face several challenges because of the transformation, needing to adapt to the new technologies of the market (Brunetti et al., 2020).

Table 1. Recommendations for future research.

Group	Recommendations for future research
Group 1: Digital literacy	- To evaluate possible divergences and similarities in digital skills between different countries and to assess whether the socioeconomic level factors detected in the Spanish population remain the same in other countries. - Identify which forms of ICT use enhance digital problem solving for different groups, but also use cross-country analysis to determine if different intangible socio-cultural factors that shape ICT use behavior.
Group2: Identifying competencies	- Conduct a review of marketing curricula to investigate the extent to which social skills are currently part of a formal curriculum, for example, in explicit learning outcomes or as a stand-alone course. - Evaluate the return on investment by governments and by the students themselves, in cases where educational programs do not match the structure of skills required in the market.
Group 3: Use of digital technologies in teaching	- Consider online courses on the Ukrainian-language EdEra platform that will allow you to creatively process educational information and improve your qualifications as a teacher, scientist, and student. - Consider coverage of a broader population and region in the civil engineering discipline or different engineering disciplines.
Group 4: Learning model	- Develop experiential activities for use in marketing courses and then investigate the effectiveness of these activities. - An exploration, through a case study, of how technology will impact the teaching and learning process of the next Alpha generation.
Group 5: Labor qualification or requalification	- Investigating whether digital certificates are influencing recruitment practices and analyzing whether digital certificates can help students and graduates secure employment. - To investigate more closely the activities carried out in the fab lab and makerspaces to assess, in terms of educational design, the specific skills that are promoted, and what kind of learning environment would be most suitable for this.
Group 6: Digital technologies in the labor market	- Study how the business sector, along with governmental and educational institutions can collaborate to meet the skill set in demand;
Group 7: Undergraduate review	- Investigating the types of computer skills most valued in the workplace would also be beneficial - Explore whether digital programs can replace traditional programs offered in colleges and schools, such as advertising, public relations, and journalism. - Regulatory framework that enables or hinders the creation and/or modification of courses.

Group 7: Undergraduate course analysis (N=11)

The studies conducted in this group examine undergraduate courses to assess the impact of changes in higher education institutions (HEIs), including curriculum modifications and teaching methodologies. The research aims to understand how these changes influence undergraduate students' learning experience and outcomes. By analyzing the effects of curriculum and teaching method adjustments, these studies contribute to ongoing efforts to enhance the quality and effectiveness of undergraduate education.

The changes generated by transformation have made it necessary to discuss the challenges in the relationship between the university and digital technologies (Nguyen, 2018). As such, Kazaishvili (2019) aims to determine whether teaching methods based on digital tools result in 21st-century skills.

Analyses of undergraduate courses to see if they prepare students for the digital market are frequent. For instance, in the case of advertising, Jones (2018) identifies the skills that students need to compete and have jobs, which include analysis and Big Data, while Xie et al. (2018) make a comparison of the public relations degree between the US and China (see also Fang et al., 2019; Nunan and Di Domenico, 2019). In accounting, Al-Htaybat et al. (2018) identify crucial skills, like data analysis and problem-solving, and suggest curricular changes in undergraduate courses, while Banasik and Jubb (2021) assess whether master's courses in Australia incorporate the specific skills for employability in this sector as the digital transformation deepens. As for industrial electronics, Bonnaud and Bsiesy (2020) conclude that an adaptation of the training of engineers and technicians in the field of microelectronics is important. This adaptation of training, which must meet quality and efficiency criteria, to the acquisition of skills and know-how is essential to meet economic, industrial and social needs. Finally, in the IT area, Fitzgerald et al. (2018) look at how one HEI made the adaptations that the market indicated were needed in the data science course. Goulart et al. (2021) also assess whether there is a difference between the skills required by the job market and those developed by HEIs in IT.

Discussion

Skills changes

The topic of digital transformation has been widely discussed in different economic sectors, and interest in it is growing, in academia and the market, as the growing number of studies that relate digital transformation to skills and education show. Organizations are encouraged to select and implement digital strategies. However, to be successful, they need employees with the required new competencies, who must arrive at the job market trained by the HEIs. For the trained employees comes the opportunity to compete, value and manage the knowledge they possess, which is seen as a source of competitive advantage.

The main contribution of this article was to systematize the knowledge about digital transformation, skills, and education. The main areas of research on digital transformation, incorporated into the groups defined in the section above, allow the development of a framework for analyzing digital transformation. Figure 3 summarizes the different research areas.

Digital Transformation has had a strong impact on the way people do business, work and live, due to the emergence of new digital technologies in the labor market (Group 6), changing the skills required by the labor market. Thus, the process of identifying the skills required in the various sectors of the economy is important to understand the new needs of the market (Group 2). Digital literacy is ever more crucial for citizens and workers (Group 1).

Another change caused by digital transformation is about the qualification or requalification of the workforce, because only with a staff qualified for the new technologies will organizations be able to implement digital strategies (Group 5).

Changes in HEIs

The new skills demanded by digital transformation require HEIs to change so that graduates enter the labor market with skills that meet the needs of employers. Changes in HEIs can be divided into three categories:

- the use of digital technologies in learning, which is an opportunity for the education sector to consider new strategies for student development (Group 3);
- the adoption of new learning models, to transform and improve teaching and learning processes to be more suitable for digital transformation (Group 4);
- the analysis of the curricula, so that they are more adequate to the demands demanded by the job market (Group 7).

Future research

During the paper, we identified some gaps in the literature. However, future research relating to the themes is needed. The main difficulty in preparing this study was the large number of areas affected by the change generated by digital transformation, which makes it difficult to flesh out the relationship among competencies, education and digital transformation. It also reveals, on the other hand, that studies in this area still need to be conducted, which proves to be a fertile field for future publications, as well as the possibility of expanding studies in this area. In Table 1, we present some recommendations for future research.

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