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Bibliometric analysis of research on digital transformation and education

Adem Özdemir [a *], Ali Tekin [a], Yusuf Yağız Saraçoğlu [a]

[a]Ağrı İbrahim Çeçen Üniversity, Türkiye

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Highlights

- Digital transformation, which emerged with distance education, is not a widespread practice worldwide and is not seen as a definite process.
- The use of digital transformation Technologies in education has increased with the Covid 19 pandemic.
- Bibliometric Analysis is that it can show the tendencies of researchers on the subject to analysis practitioners.

Article Info: Review Article

Keywords: *Digital, Digital Transformation, Education, Higher Education, Bibliometric Analysis*

Abstract

Recent technological developments have brought about innovations in many fields, such as education, health, economy, and finance. One of these innovations is the concept of digital transformation, which changes the way businesses, institutions, and organizations do business. The concept of digital transformation began with the Fourth Industrial Revolution and brought new technologies to it. The emergence of digital technologies has revolutionized various aspects of society, including education. Digital transformation has emerged as a powerful catalyst that reshapes traditional educational practices and offers new opportunities for teaching and learning. In particular, with the Covid-19 pandemic affecting the whole world, online education has become very important, and all educational institutions have started to integrate their systems into this change. In addition, with the philosophy of lifelong learning, it has become very easy to access training on digital platforms. In line with this information, this study aims to reveal the developments in the historical process of digital transformation and education between 2000 and 2023 in the Web of Science database and to carry out bibliometric analysis by scanning the articles and books published to determine the most studied topics in the field. To achieve the aim of the study, the keywords “digital transformation and education” were scanned. As a result of this search, 2,739 publications were published. These publications were analyzed according to year, research area, country-based distribution, subject distribution, and the most used keywords. As a result of the research, when the research areas of the articles are examined, it is seen that the most studied area is "Education and educational research" and "business". This situation can be said that digital transformation is a very remarkable subject in the field of education and business. When we look at the distribution according to years, it is clear that the greatest acceleration occurred in the last five years. This shows that digital transformation has been increasingly emphasized in recent years. In terms of countries, the subject is studied more in countries such as Germany, Spain, the United States, and Russia.

1. Introduction

To exist as a power in the competitive economy of tomorrow is only possible with an agile governance approach that interprets the requirements of the time, takes, and implements decisions quickly and with the capacity to produce innovative technological solutions. Today, in line with the opportunities offered by rapidly developing information and communication technologies and changing social needs, there is a need for holistic transformation that brings together human, business process, and technology elements. This

* Corresponding author. Ağrı İbrahim Çeçen Üniversitesi, Eleşkirt Meslek Yüksekokulu, Ağrı, Türkiye.
e-mail addresses: aozdemir@agri.edu.tr, alitekinl@agri.edu.tr, ysaracoglu@agri.edu.tr
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transformation, “which places the human mind at the highest point and includes many technologies, such as the Internet of Things, cloud computing, blockchain, big data, and artificial intelligence, brings radical changes in business processes and social life” (CBDDO, 2023).

This transformation, which started with the coding of analog data into digital media as 0 (zero) and 1 (one), has primarily integrated digitalization into our lives. Digital data obtained through digitalization are processed and used more effectively and efficiently. Digital, which means digital in Turkish, is not limited to a concept that describes only electronic transactions and tools. It is a concept that describes the processing of information, which has an important place for human beings from the past to the present, albeit in different formats. Therefore, the most important action in the digital world is the process of processing 1's and 0's brought together by combinations in an infinite loop. In this process, raw material is data, which are transformed into information in a context, information is obtained by attributing meaning to information, and the understanding of information opens the way to wisdom. Digital transformation, which has gained momentum with globalization, can be expressed from this perspective as the digital processing of data and its use by people (Bozkurt et al., 2021). Digital transformation has become inevitable with the emergence of new technology. Today, everything is transforming into digital. From books to newspapers and magazines, music to cinema, education to health, games to sports, entertainment, and culture, many things have become digital. In short, it has become digital.

Digital transformation can be defined as the digitalization of all business processes, starting from the procurement process with the development of new technology and including all business functions. Consequently, designing and producing products to meet customer demands with customer integration, collecting data from all processes and processing these data, and responding to customer needs in a way to gain competitive advantage (Özdemir & Tan, 2023).

All these events started with the discovery of silicon electromagnets, and the use of semiconductors in transistors and transistors facilitated the invention of microchips. With the announcement of Industry 4.0, at a fair in Hannover, Germany, in 2011, everything started to change and transform. Industry 4.0, which is inevitable for businesses, and the new technologies it introduces, have accelerated this transformation. All sectors from health to culture, manufacturing to tourism, food to textiles, and service to education started to keep up with this transformation. In 2019, the importance of digital transformation was once again understood by the Covid-19 outbreak that affected the entire world. Education and training activities must continue with digital or distance education systems at all education levels. Educational institutions prepared for this change have been able to continue education without interruption by integrating their systems into digital education.

2. Digital Transformation and Education

Digital transformation is a continuous and dynamic process (Teichert, 2019); therefore, there is no consensus on what digital transformation is and what its scope includes (Haffke et al., 2016; Schallmo & Williams, 2018). Digital transformation is a process that involves many paths and stages, concerns the business models, strategic orientations, and values of organizations (Brooks & McCormack, 2020), and involves not only technical dimensions but also social dimensions (Bonfour, 2016; Kane et al., 2015; Osmundsen et al., 2018; Stolterman & Fors, 2004). From this point of view, studies on digital transformation show that the concept of innovation is at the center of digital transformation, and that digital transformation and innovation are often used interchangeably (Osmundsen et al., 2018; Reis et al., 2018).

In educational institutions trying to adapt to the digital transformation process, digital transformation is necessary to capture change and gain the power to compete in the global race (Ataş & Gündüz, 2019; Gümüşoğlu, 2017; Taşçı & Çelebi, 2020). The rapid and noticeable digitalization occur in daily life has led

to the realization of the need for change in the education and training process. It is pointed out that the opportunities offered by digitalization in the new society make people's lives more compatible, sustainable, facilitating, accessible, comfortable, and safe in every sense (Puncreobutr, 2016). The changes in education systems have gone through four basic processes of change and transformation in general terms, namely 1.0, 2.0, 3.0, and 4.0, in connection with industrial revolutions:

Education 1.0 was designed to meet the needs of agricultural society, and information was transferred from the teacher to the student with the help of concepts and memorized by the student (Puncreobutr, 2016). Extensive studies are required to learn about the events and relevant information. Students mostly had to follow their teachers and apply the methods that they used. The development of new methods is the main objective (Wallner et al., 2016).

Education 2.0, which has been shaped to meet the basic needs of the labor force in the industrial society and to teach the technology to be used, has been the goal of education. According to the input and output perspective brought about by the period, educational institutions in this period were seen as factories and students as products produced in the factory (Pooworavan, 2015). The contents of education pointed out the basic qualifications of the students. Examinations started to be seen as quality control of the education system, and diplomas as a guaranteed document. At this stage, the learning process, defined by Bloom, is a force that directs educational systems (Bloom et al., 1964).

Education 3.0, a process that expresses information and production-oriented structuring. At this stage of the transition from an industrial society to a technological society, the Internet has begun to be used intensively in information production. In the education process, the Internet, especially the opportunities offered by Web 2.0, has been utilized, a stage in which everyone can produce information, and self-learning approaches have been emphasized in teaching. The use of technology in educational environments has brought about changes in traditional educational environments (Harkins, 2008). When the information-oriented structuring of society began, education systems naturally began to be structured in a way to meet the needs of the "technology society". The phenomenon of "self-learning" emerged on the basis of this period. With the use of digital media, the period in which social media, especially the Internet, made itself feel predominantly in education systems began. Computer-aided interactive education systems have also emerged. Another important transformation that emerged in this period is that students are educated as "knowledge producers" instead of "knowledge consumers" (Rosik, 2017). At this stage, it is essential to ensure the quality assurance of education systems. Starting with the Bologna process (Crosier & Parveva, 2013), joint multinational education programs and systems have been put into operation.

Education 4.0 refers to the innovation and education-oriented process that society needs in an innovative age (Harkins, 2008). While "teaching technology in education" with 2.0 transforms into "use of technology in education" with 3.0, it transforms into "design and innovative use of technology in education" with 4.0. To live in society at the age of innovation and be equipped with the best of their abilities, Education 4.0 needs to go far beyond reading, writing, and arithmetic, which are listed as the skills of the education system of the past (Puncreobutr, 2016). This requires individuals to have their own learning management systems and to determine their own learning paths (Bates, 1997; Puncreobutr, 2016). In the Education 4.0 approach, it is stated that constructivist education systems will be applied in general, and a learning process based on the three areas described below will be applied (Öztemel 2018):

- 3R (Recalling-Recalling, Relating-Relating, Refining-Refining) regulating comprehension

- 3I (Inquiring-Inquiry, Interacting-Interaction, Interpreting-Interpretation)

- 3P based on producing results (Participating Being, Processing- Processing, Presenting- Presenting)

To provide students with these skills, visual learning, personalized education systems, gaming and scenario-based learning, project-based problem-solving, and the use of approaches such as augmented reality (Öztemel, 2018). Learning models have been updated through digital transformations in education. The learning models that emerged as a result of digitalization can be explained as follows (Davidson & Goldberg, 2009; Taşkıran, 2017).

Blended Learning Model: Which learning model that takes place in both the classroom and online platforms. Blended learning is a type of learning environment in which different models used in face-to-face education and distance education involving computer- and web-based learning are brought together and organized to achieve maximum learning (Uğur, 2007). In addition, learning is the reduction of the time spent in the classroom environment by combining the best aspects of the traditional method and web-based learning method in the learning and teaching process (Garnham & Kaleta, 2002). Driscoll and Carliner (2005) stated that blended learning can also be approached as a programmed design strategy, in which learning programs in different formats (e-learning, classroom learning and other online learning strategies) are combined to form a single whole. Another important point is that in blended learning environment designs, the aim is to plan the two different learning environments (online and face-to-face) in a way that includes the strengths of the two different learning environments (online and face-to-face) according to the content of the course being taught and to design the weaknesses in such a way that they are not included in the content as much as possible (Horton, 2000; Osgurthorpe & Graham, 2003).

Rotational Learning Model: This model allows students to carry out learning processes at their own pace with one-to-one lessons in the classroom environment and includes online learning support (Davidson & Goldberg, 2009). The Rotation model involves students rotating between various learning methods, including online learning, within a particular subject or course such as mathematics. The rotation can be either scheduled or decided by the teacher and may include activities such as small-group or full-class instruction, group projects, individual tutoring, and traditional pencil-and-paper assignments. There are four submodels of the rotation model: Station Rotation, Lab Rotation, Flipped Classroom, and Individual Rotation. In the rotation model, students can receive instruction and complete assignments in the classroom while also having the opportunity to work independently or remotely using offline materials. This approach can help bridge the digital divide and ensure that all students have access to quality education regardless of their access to technology at home (Kömür et al., 2023).

Flexible Learning Model: A model in which a large part of the training program is conducted online, and teachers can respond instantly online when needed (Taşkıran, 2017). The concept of flexible learning was introduced by Barnett (1992) and has gained considerable attention due to its acceptability among learners, especially because it provides the freedom to choose the pace, place, and mode of delivery (Damary et al., 2017; Ryan & Tilbury, 2013) for their studies. These features and ease of delivery incorporate technological developments, the extension of new pathways and the globalization of the education sector as the main dynamics to attract educational institutions towards flexible learning. Flexible learning is a complex phenomenon incorporating four key components. The first is the institution, which is responsible for making sure flexible systems, offering learners choices, are put in place, and maintaining the framework to ensure a quality learning experience. The second is implementation, which is usually controlled by instructors and centers on instructional approaches and delivery. Palmer (2011) emphasized key aspects in creating flexible learning: (i) time, (ii) content, (iii) instructional approach/design, and (iv) delivery. Pedagogy is the third component, which, according to Ryan and Tilbury (2013), has learner empowerment at its core; it also emphasizes dynamism in the learner–educator relationship.

Personal-Blend Learning Model: One or more courses are offered online according to the needs of students in addition to classroom learning (Taşkıran, 2017).

Online-Laboratory Learning Model: A model based on the delivery of all courses on online platforms in the school environment, but allowing students to consult their teachers when they have difficulties in understanding (Taşkıran, 2017). Currently, the remote laboratory system is an important and supplementary part of learning to bridge the gap between theory and practice. New technologies have provided laboratories with a different form of observation, experimentation, and investigation, whereby distance learning has garnered the attention of researchers (Chirikov et al., 2018; Chirikov et al., 2020). Remote laboratories provide opportunities and flexibility for students to conduct experiments at the level of ability and pace of learning each student, anytime and anywhere (AbuShanab et al., 2016; Schauer et al., 2015; AbuShanab et al., 2018; Maiti et al., 2017). Hence, remote laboratory systems have been designed to provide remote access platforms for learners from distant places (De La Torre et al., 2020; Machado et al., 2018).

Enriched Virtual Learning Model: A model in which students are not in a physical school environment or education is provided through an online platform. Enriched Virtual model—a whole-school experience in which, within each course (e.g., math), students divide their time between attending a brick-and-mortar campus and learning remotely using online delivery of content and instruction. Many Enriched Virtual programs began as full-time online schools and then developed blended programs to provide students with brick-and-mortar experiences. The Enriched Virtual model differs from the Flipped Classroom because in Enriched Virtual programs, students seldom attend the brick-and-mortar campus every weekday (Hunsinger, 2019).

Connected Learning Model: A model that is interested in what students learn and emphasizes instantaneous or non-immediate learning processes (Taşkıran, 2017). Connected learning can be realized (simply) when a person is able to pursue a personal interest or passion with the support of another (friends, caring adults, knowledgeable others) and is in turn able to link this learning and interest to academic achievement, career success and or civic engagement (Ito et al., 2013). Its purpose is to enrich the co-creation of foundational literacy and knowledge as well as diversifying and multiplying pathways to opportunity and meaningful participation in society. Therefore, connected learning does not reduce learning to a phenomenon that takes place exclusively in the restricted spaces of formal education and does not focus exclusively on social media or online learning. Rather, it refers to any learning experience where people co-create and share artifacts meaningful to their community (centered production), which affords abundant resources accessible to all (openly networked) who share a common purpose (shared purpose) (Asmussen & Creswell, 1995).

Networked Learning Model: A learning model that focuses on network dimensions. It defines as: learning in which information and computer technologies are used to promote connections: between one learner and other learners; between learners and tutors; between a learning community and its learning resources (Goodyear, Banks, Hodgson & McConnell, 2004).

Social Learning Model: Social learning is strongly grounded in learning theory and focuses on elements of learning that are relevant when learning in a participatory online culture. They shift attention away from summative assessment of individuals' past performance in order to render visible, and in some cases potentially actionable, behaviors and patterns in the learning environment that signify an effective process. In particular, the focus of social learning is on processes in which learners are not solitary, and are not necessarily doing work to be marked, but are engaged in social activity, either interacting directly with others (e.g., messaging, friending, or following), or using platforms in which their activity traces will be experienced by others (for example, publishing, searching, tagging, or rating) (Shum & Ferguson, 2012).

Situational Learning Model: Game-oriented and cooperative learning the theory of situational learning was developed by Jean Lave and Etienne Wenger (1991), who believed that students were likely to learn more by actively participating in their learning domain as opposed to listening to lecturers in classrooms. Situational learning is a mechanism that creates meaning through real-life activities in which learning occurs. This model of learning is a part of Lave and Wenger's theory of communities of practice, which also states that learning should not be merely viewed as the transmission of knowledge but as an embedded and active process.

Adaptive Learning Model: This is a learning model that plans learning according to student needs (Taşkıran, 2017). The goal of adaptive learning is to customize the learning experience by dynamically making changes based on the interactions and inputs provided by the learner (Somyürek 2015). This approach provides immediate feedback that is targeted and tailored to the learning process and focuses on improving student learning (Johnson et al. 2009; Kelly 2008; Kerr 2016; U.S. Department of Education 2013).

The rapid development of technological devices has also changed individuals' needs. In other words, the development and change in technology also affects the teaching process by changing the method of access to information and speed of access to information (Alakoç, 2003). The "technological tools used in the field of education have become increasingly diversified. In recent years, digital content such as video projectors, smart boards, mobile devices, e-books, downloadable music, uninterrupted audio and video networks, and online social networks have become technological developments that affect the lives of the majority." To respond to the changing needs of the generation and to improve their teaching environment, it has become inevitable to use technology for teaching purposes. From this perspective, digital transformation is a necessity rather than arbitrariness, and it should be implemented in areas that will add quality to our lives, such as education, health, public administration, and industry. Considering the Digital Competitiveness Report (International Institute for Management Development, 2019), which states that the overall performance of national economies is measured by three main components defined as "knowledge", "technology" and "future readiness", the issue of digital transformation in education gains even more importance.

When we look at the research published in recent years, it is seen that digital transformation and education are topics of interest to the academic world. Research in this field has attracted immense attention. Figure 1 shows the distribution of the research on digital transformation and education by year.

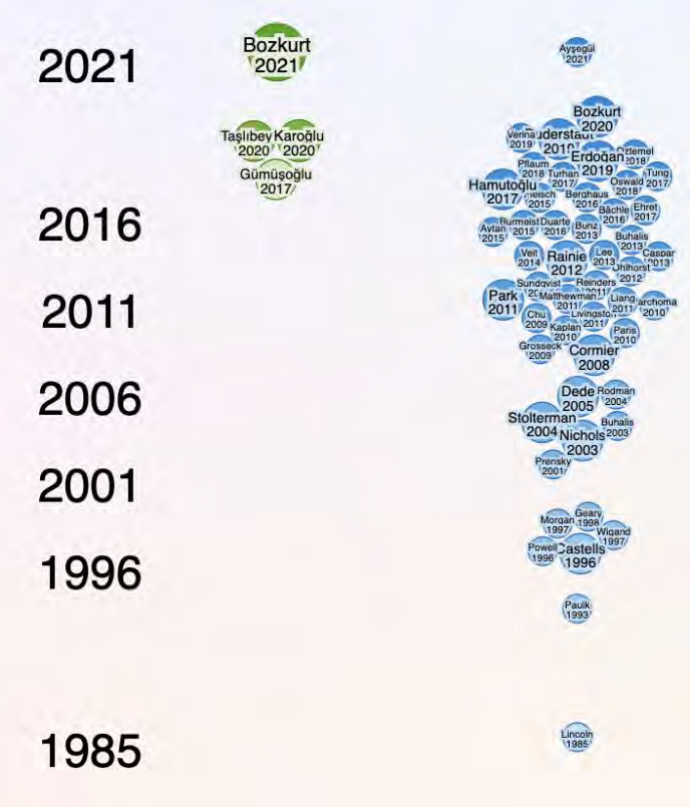

Fig 1. Distribution of publications on digital transformation and education by years (https://researchrabbitapp.com/home)

Figure 1 shows that there has been a significant increase in publications on digital transformation and education since 2011.

3. Methodology

Bibliometric analysis is a quantitative application that helps researchers conduct scientific research. Owing to bibliometric analysis, researchers have information about many variables, such as countries, publications, and authors in their field of interest. In addition, bibliometric analysis provides an opportunity to map this information. Thus, researchers can map the cognitive structure of a field of interest by clustering (Van Eck and Waltman, 2010).

3.1. Research Model/Design

The research model was realized by considering that digital transformation and education have been studied together, particularly in recent years. Therefore, an exploratory research model was designed by choosing the keywords "digital transformation" and "education".

3.2. Data Collecting Tools

The Web of Science Core Collection was used as the database for the data collection. The Web of Science Core Collection is important for publishing publications with widespread impacts in the international arena (Herrera and Heras-Rosas, 2020). In this database query, the words "education" and "digital transformation" digital transformation', preferred within the scope of the research model, were used. The scope of this study was selected as the topic. There were no language restrictions in the search, and the types of publications

were determined as 'article' or 'book' or 'book chapter' or 'data paper' or 'database review' or 'letter' or 'note' or 'review'. The study was restricted to the period 2000–2023.

3.3. Data Analysis

Consequently, 2,739 publications were identified. While exporting these publications as text documents from the WoS site for bibliometric analysis, the 'full record and citation data' option was preferred. Thus, it was possible to analyze all downloaded publications together with their citation counts. Because the data were downloaded from WoS in raw form and in groups of 500, some corrections were required. To avoid reanalysing the names of some authors or institutions, the data were edited and merged using Microsoft Excel. As the WoS number of publications could not be found during this editing process, the analysis continued with 2,739 publications. The VosViewer package programs were used to visualize and tabulate the data. VOSviewer is a computer package program that makes it possible to see the links between authors and keywords, and bibliometric maps have been created and displayed (Waltman, 2010; Chen, 2014).

3.4. Findings and Discussions

Digital transformation and education have been topics that have attracted the attention of researchers, particularly over the last 20 years. The number of related scientific studies has increased daily, and a steady increase in studies has been observed to date.

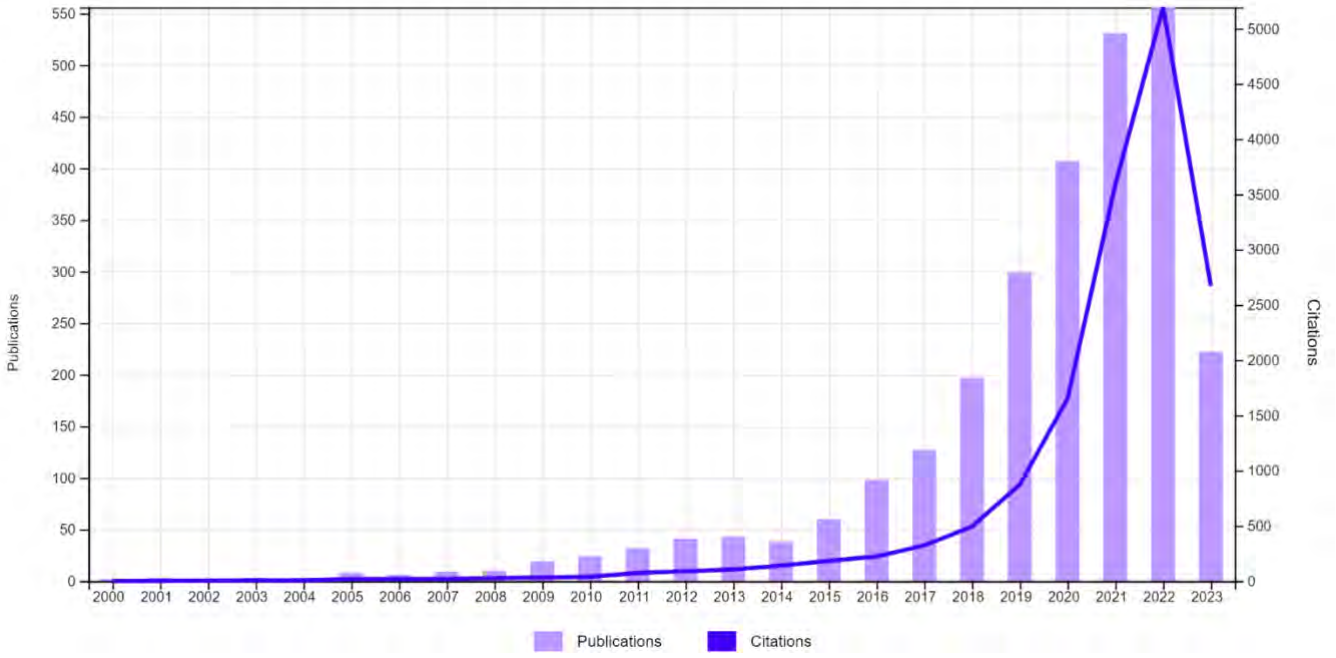

Fig 2. Citations and publications on digital transformation and education by years (https://www.webofscience.com/wos/woscc/citation-report)

The tree chart graph of studies on digital transformation and education in the WoS database according to their subjects (Fig. 3.). With 1,016 studies, "Educational Research was the most studied subject. "Computer Science Information Systems" with 177 publications, "Computer Science Interdisciplinary Applications" with 170 publications, "Education Scientific Disciplines" with 165 publications, and "Business" with 159 publications make up the top five.

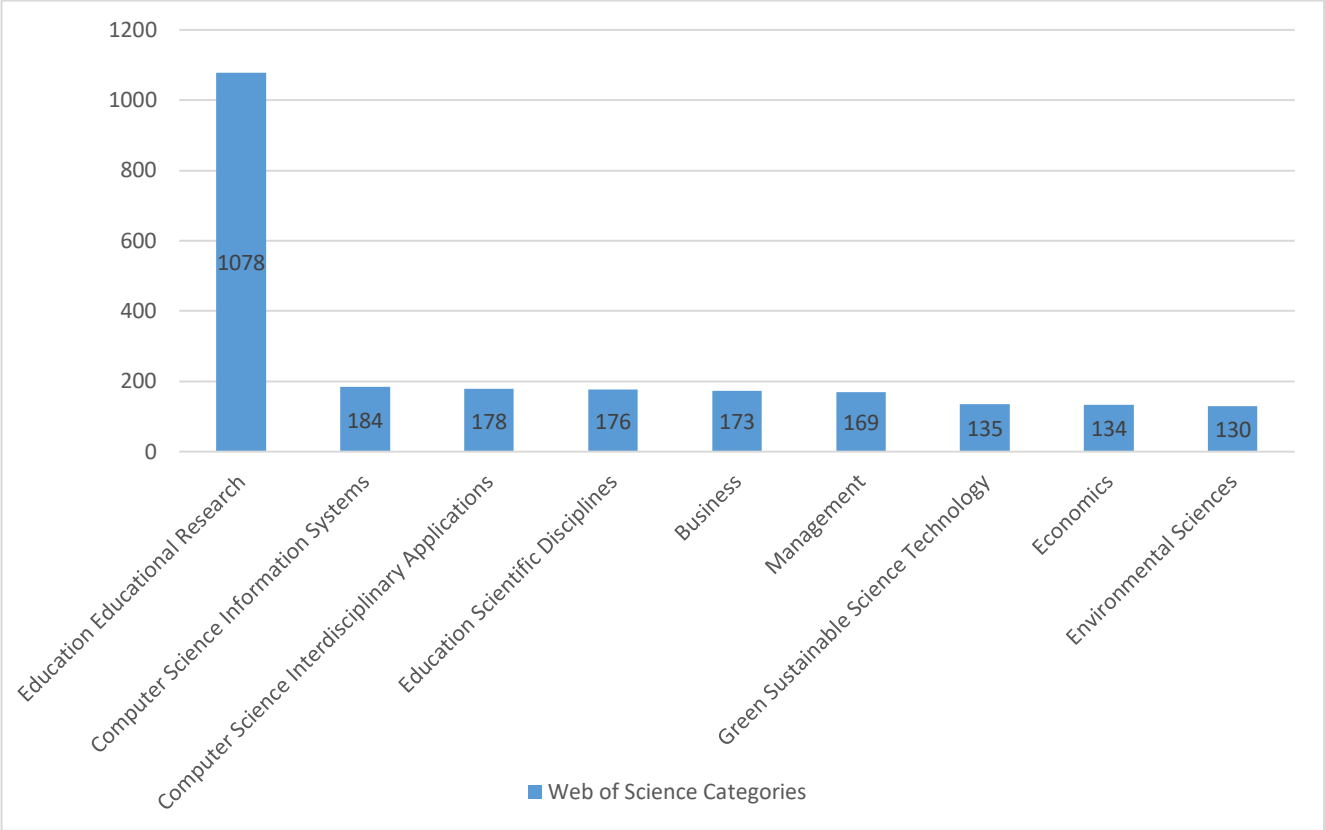

Fig 3. Bar Chart of studies on Digital Transformations and Education (https://www.webofscience.com/wos/woscc/citation-report)

As a result of the bibliometric analysis, the authors with the highest number of citations are shown in Table 1. The authors with the highest number of citations in studies on digital transformation and education are Sachs and colleagues. Their study "Six Transformations to achieve the Sustainable Development Goals" received 571 citations in the WoS database.

Table 1. Citation Rank of Authors

	Authors	Documents	Citations
1	Sachs, Jeffrey D.	1	571
2	Mazzucato, Mariana	1	571
3	Messner, Dirk	1	571
4	Nakicenovic, Nebojsa	1	571
5	Rockstroem, Johan	1	571
6	Schmidt-Traub, Guido	1	571
7	Littlejohn, Allison	1	472
8	Margaryan, Anoush	1	472
9	Vojt, Gabrielle	1	472
10	Iivari, Netta	3	281

It is important for researchers to be able to access lists of authors with the most publications and citations in the field related to the research topic. Knowing which author has the highest productivity in the

international literature on the subject they are interested in, or which author's works are attracting attention in the academic literature allows researchers to conduct healthier and more effective literature reviews on the relevant subject.

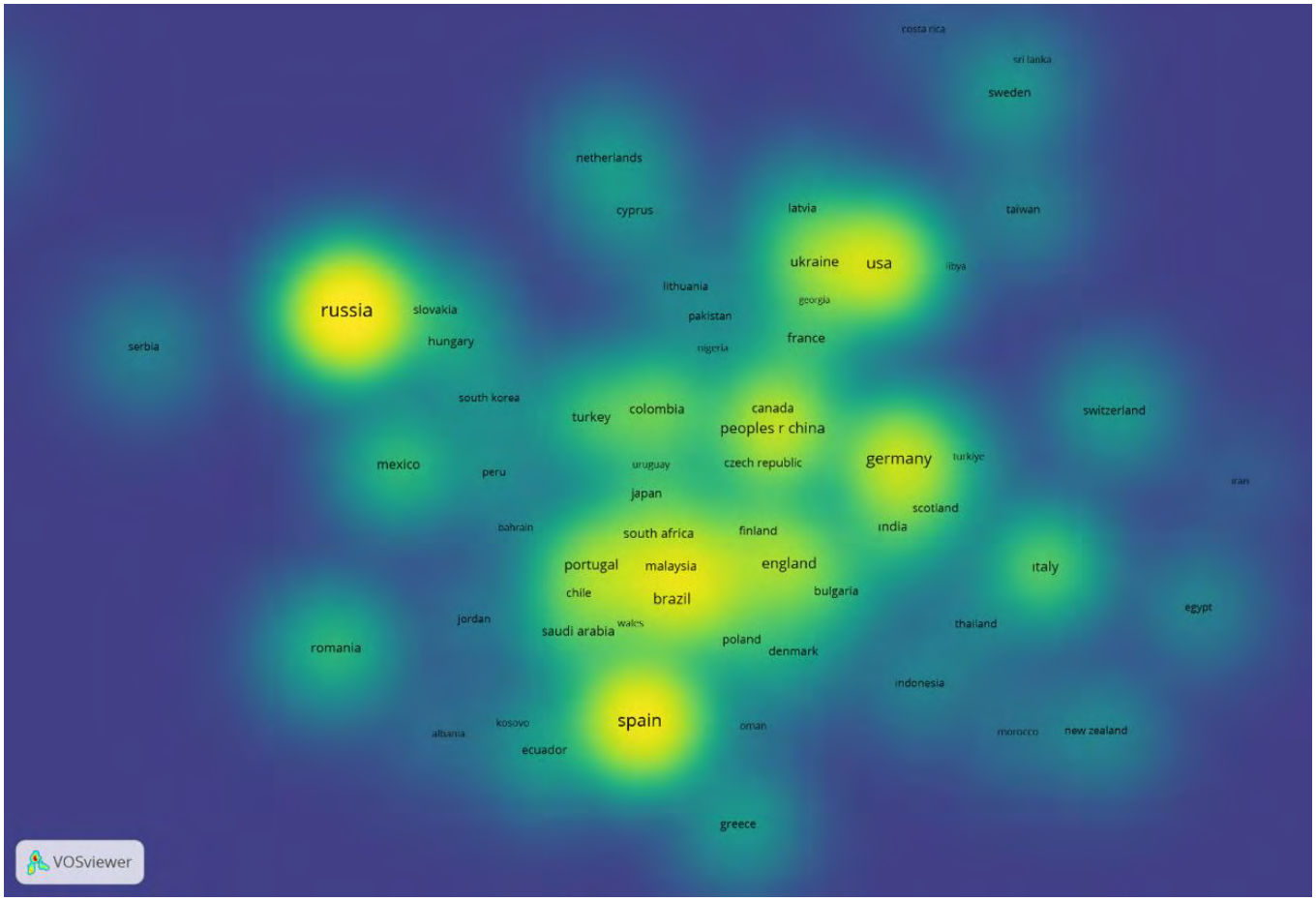

Fig 4. Countries Density Visualization

The density graph of studies on digital transformation and education is based on countries in the WoS database (Fig. 4.). It is noteworthy that the United States, Russia, and Spain are the countries with the most intensive studies in relevant fields and databases. At the same time Brazil, China, and Germany also had the highest densities. The United States, the United Kingdom, and Spain are among the top 3 in citation and publication rankings (Table 2).

The country with the highest number of citations is the United States and the country with the highest number of publications is Russia. The density and ranking data should be in parallel. A citation-based ranking was created when Table 2 was analyzed. The USA ranked first (3579 citations), the UK ranked second (2416 citations), and Spain ranked third (2411 citations). In the WoS database, there are a total of 121 countries conducting studies on digital transformation and education. Turkey ranked 33rd out of 121 countries (65 publications, 192 citations). When the ranking of institutions was analyzed, University College London ranked first (602 citations), Columbia University second (571 citations), and Potsdam University third (571 citations).

Table 2. Ranking of Countries and Institutions

	Countries	Doc.	Cit.		Institutions	Doc.	Cit.
1	USA	223	3579	**1**	University College London	7	602
2	England	127	2416	**2**	Columbia University	2	571
3	Spain	303	2411	**3**	University of Potsdam	1	571
4	Germany	196	1851	**4**	Sustainable Development Solutions Network	1	571
5	Australia	102	1419	**5**	United Nations University	1	571
6	France	51	1201	**6**	International Institute for Applied Systems Analysis	1	571
7	Russia	401	909	**7**	Glasgow Caledonian University	1	472
8	Austria	42	802	**8**	University of Salamanca	18	342
9	China	116	782	**9**	University of Bradford	2	330
10	India	58	740	**10**	Indian Institute of Management–Tiruchirappalli	1	328

One of the greatest conveniences of bibliometric analysis is its keyword network map. With this network map, we can understand which keywords are used, which keywords are most preferred by researchers, and what kind of network connections exist between these preferred keywords.

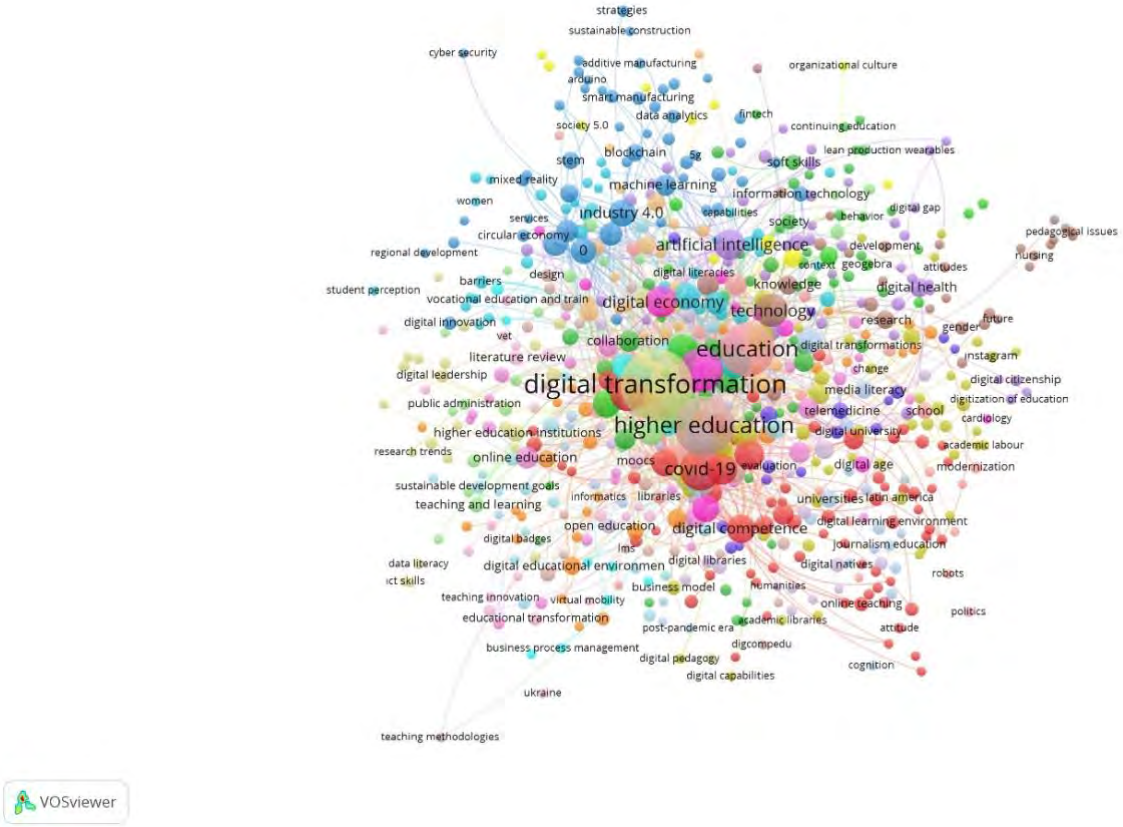

Fig 5. Keywords Network Visualization

When the studies on digital transformation and education were analyzed in the WoS database, 7296 different keywords were used. The most preferred keyword is "digital transformation" (6.5%, n=474). Fig. It is thought that the keywords shown in Fig. 5 will provide information to researchers about today's trends in studies on digital transformation and education. The network map shown in Fig. 5. was created by considering publications using at least three keywords. Accordingly, 708 nodes, 25 clusters, and 6780 connections emerged.

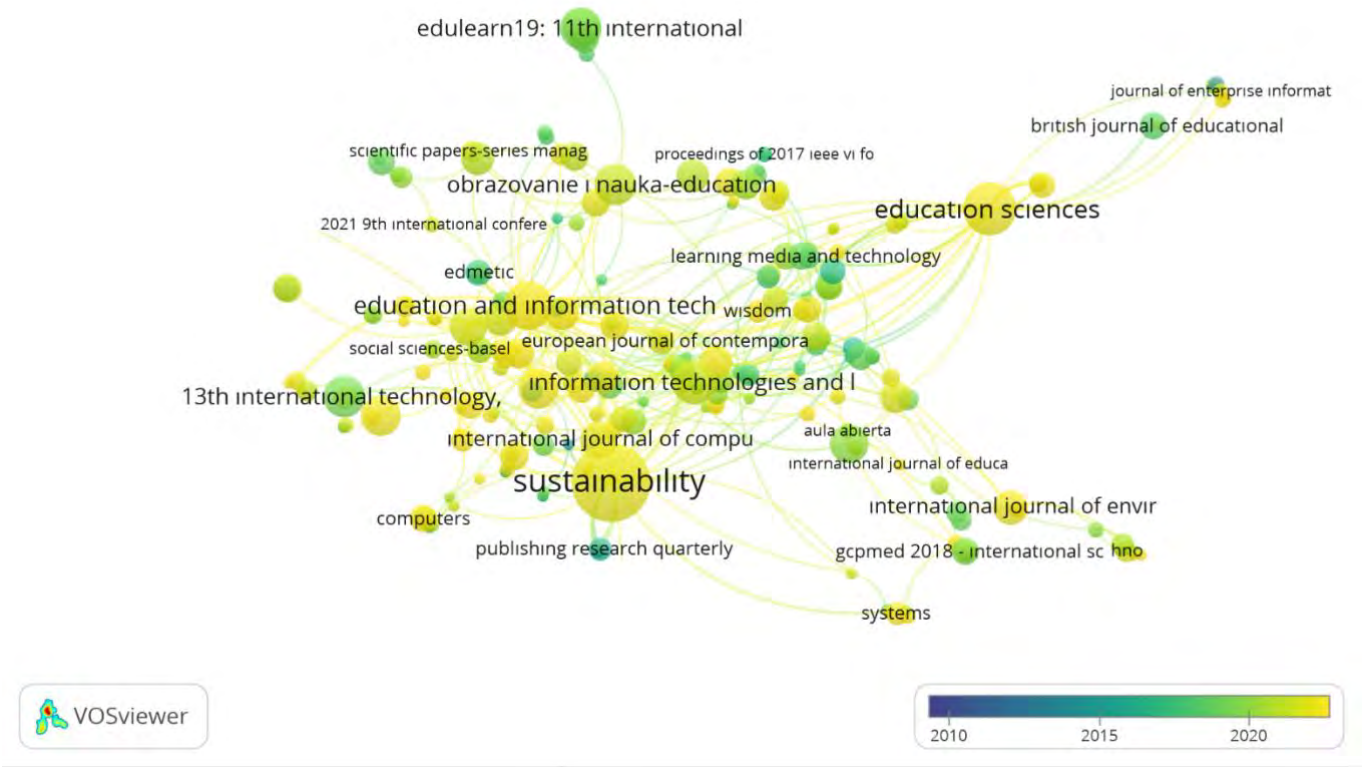

Fig 6. Sources Overlay Visualization

It is important for researchers to review the literature and publish their research in an academic field. Among the conveniences that bibliometric analysis provides researchers are journals. Through bibliometric analysis, we can learn which journals have publications about interest and the number of citations. In addition, we can see the interest of journals in the research topic over the years. In studies on digital transformation and education, the number of publications and citations increases as we approach the present day (Fig. 6). As the coloring increases towards blue, we can infer that the interest in the researched topic decreases, and as it approaches yellow, we can infer that the topic is current. The journal that ranks first in citation ranking for studies on digital transformation and education is "Sustainability". Sustainability is a journal that includes studies examining sustainability and development issues (MDPI, 2023). Fig. 6. shows journals that include research on digital transformation and education and their connections with each other.

4. Conclusion and Suggestions

This article has two aims: (1) to explore the literature to understand the role of digital transformation in education, and (2) to reveal the link between digital transformation and education by conducting bibliometric analysis to underline how researchers focus on this issue. Digital transformation, which is summarized as making business processes faster, more efficient, and more effective through digital channels with technological developments, has started to be used at all levels of the education sector, as in

all sectors. Digitalization, which has increased its impact and the number of users in recent years, has strengthened its relationship with education in every field. The number of studies on digital transformation and education has increased in the recent years. However, the number of studies analyzing all of these studies was quite small. This study conducted a bibliometric analysis of studies on digital transformation and education.

Our study was carried out with the aim of examining the research published in the international literature on digital transformation and education in the WoS database, in line with various parameters. For this purpose, a bibliometric analysis technique was used to look at parameters such as countries and authors with the highest number of publications on digital transformation and education, the journals and contents of the publications, and the preferred keywords.

The most cited authors in publications on digital transformation and education worldwide are Sachs et al. After searching the WoS database, the most cited publication is “Six Transformations to achieve the Sustainable Development Goals”. In this publication proposed six transformations to achieve sustainable development goals and argued that two of these six are “education” and “digital transformation”.

When publications on digital transformation and education by country were analyzed, the United States ranked first with 3579 citations, while the United Kingdom and Spain ranked in the top three with 2416 and 2411 citations, respectively. Examining the number of publications on digital transformation and education, Russia has 401 publications. When publications on digital transformation and education by universities are analyzed, University College London (England) stands out with seven publications and 602 citations. The journal that includes the most publications on digital transformation and education is the scientific journal “Sustainability”. The journal has 89 publications on this subject, with 917 citations. This situation shows us that a researcher who wants to conduct a study on digital transformation and education should not proceed without looking at the relevant journal.

Especially with the pandemic affecting our lives globally, the concept of digital transformation has come to the fore with the increase in the time spent at home during the isolation process. When our graph on keywords is examined, it can be seen that the word Covid-19 comes to the fore. This situation reveals that researchers have tended to focus on digital transformation during and after the pandemic (Nurhas, Aditya, Jacob, & Pawlowski, 2022). Covid-19 forced digital transformation in education all over the world in early 2020. Digital transformation, which emerged with distance education, is not a widespread practice worldwide and is not seen as a definite process (Bogdandy, Tamas & Toth, 2020). However, with the impact of the pandemic, it has become imperative to realize a comprehensive digital transformation in education in order to meet the needs of the younger generation in schools and children's education (Iivari, Sharma, & Ventä-Olkkonen, 2020). Disruptions in education due to the pandemic and attempts to maximize these disruptions through digitalization have prompted researchers to study digital transformation and education.

Bibliometric analysis of research on digital transformation and education can provide valuable insights into the state of educational research in this field. This study can help to identify key trends in research related to digital transformation and education. This includes the most frequently studied topics, publication outlets in which this research is published, and most active researchers in the field. Understanding these trends can inform educators, policymakers, and researchers regarding the current focus of the field. Bibliometric analysis can be used to create visual maps of the research landscape, showing the connections between different topics, keywords, and concepts within the field. This can help researchers and educators to identify well-explored areas and areas where more research is needed. This study could be used to measure the impact of research articles and authors on digital transformation in education. This includes assessing the number of citations, journal impact factors, and influence of specific research contributions. High-impact research can help guide future directions in this field. By analyzing citation patterns and co-authorship

networks, bibliometric analysis can help identify pioneering works and influential researchers in the field. This can provide insights into the historical development of the field and help newcomers to understand foundational research. This study reveals the collaboration patterns between researchers and institutions. Understanding how different researchers and organizations work together can help build networks and foster collaborative research initiatives. By analyzing recent publications and emerging keywords, bibliometric analysis can provide insights into the potential future directions of research in digital transformation and education. Researchers have often used emerging trends and keywords to project the evolving nature of their fields. This study can help to identify gaps in the existing literature, which can guide future research. Researchers can use this information to design studies that address these gaps and contribute to a more comprehensive understanding of the digital transformation in education.

One of the greatest advantages of bibliometric analysis is that it can show the tendencies of researchers on the subject to analysis practitioners. In this way, a researcher conducting a bibliometric analysis on a topic can understand the trends on that topic at the international level.

It may be recommended for researchers who will conduct different studies in the same field to conduct research by adding different databases, not only the Web of Science database, and to work on the basis of content, title, and keywords, not only on the basis of subject.

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