Review Article

Digital Transformation in Education: A Comprehensive Bibliometric Analysis, Government Initiatives and Challenges

Priya Dahiya[1], Somya Kishnani[2], Shivani Kishnani[3], Rinki Dahiya[4] & Deepika[5]

[1]Assistant Professor, Department of Commerce, Sri Guru Nanak Dev Khalsa College, University of Delhi

Email Id: priya.dahiya@sgndkc.du.ac.in

[2]Assistant Professor, Department of Commerce, Keshav Mahavidyalaya, University of Delhi

[3]Assistant Professor, Department of Commerce, Jesus and Mary College, University of Delhi

[4]Assistant Professor, Department of Economics, Sri Guru Nanak Dev Khalsa College, University of Delhi

[5]Assistant Professor, Department of Political Science, Indraprastha College for Women, University of Delhi

Abstract

The escalating significance of digital transformation in education signifies a paradigm shift in learning delivery, driven by technological advancements like AI, virtual reality, and data analytics. It aims to enhance accessibility, personalise learning, and foster collaborative experiences. This research explores the evolution of digital transformation research in education, tracing its trajectory from basic tools to comprehensive restructuring. A bibliometric analysis reveals a surge in research publications post 2019, influenced by seminal articles and the COVID-19 pandemic. Citation analysis highlights impactful papers, emphasising the pandemic's profound impact on digital education. Keyword network maps and cluster analysis unveil research trends, while initiatives in India exemplify government efforts in digital education transformation, ensuring inclusivity and accessibility.

Despite digital transformation's positive impact on education, strategic high-level challenges persist. Resistance to change impedes the adoption of new methods, necessitating effective leadership, pilot projects, and orientation programs. Technology infrastructure challenges, including glitches and data security concerns, underscore the need for investments in stable technologies. Compatibility issues with existing systems and the lack of a clear strategy pose hurdles, emphasising robust planning and phased implementation. Additionally, inferior technology skills and inequality in access necessitate training programs and measures to address socio-economic disparities for successful digital transformation in education.

Keywords: Digital transformation, Education sector, Bibliometric analysis, Online learning, Government initiatives, National Education Policy 2020

Introduction

The digital revolution has touched almost every aspect of our lives. With over 3.5 billion people connected to the internet and more than 5 billion owning mobile devices, the world has become more interconnected than ever before. This connectivity has transformed

how people interact with each other, access information, and perceive the world around them. Unsurprisingly, the education sector has not been immune to these changes. Digital technologies have become indispensable in education due to globalisation, leading to a significant shift in how teaching and learning are conducted in schools and universities. From information transfer to student evaluation and administrative processes, digitalisation is revolutionising every aspect of education, aiming to provide enhanced opportunities for effective learning.

Educators across all levels, from primary schools to higher education, are adapting to digital transformation, reshaping not only classroom dynamics but also transforming how teachers engage with their students. The primary objective of digital transformation in education is to create a more efficient, effective, and accessible learning environment. Key principles guiding investments and actions in digital learning include prioritising marginalised groups, offering free high-quality digital education content, and fostering pedagogical innovation and change.

Digital transformation benefits both teachers and students by providing a variety of online learning options and enabling mobile learning. Hybrid courses, personalised instruction, and innovative teaching techniques are becoming more prevalent, offering new learning opportunities for students. Additionally, students are encouraged to not only consume digital content but also become proficient producers of digital media, showcasing their knowledge and ideas through various digital platforms.

While online learning platforms existed before, the global impact of COVID-19 accelerated the adoption of online teaching as educational institutions worldwide were forced to transition to online learning to sustain the education system. The pandemic pushed over 1.5 billion students into online learning environments, prompting educational institutions to embrace digital strategies for handling lockdown situations.

Digital technologies help students acquire essential skills for the future workplace, such as problem-solving and critical thinking. Educational resources and digital tools enhance classroom atmosphere and allow for more flexible curriculum customisation to meet individual student needs. Integrating technology into education makes learning more engaging and dynamic, sparking students' curiosity and increasing their engagement levels.

In conclusion, digital transformation in education offers flexibility for teaching and learning from remote locations and supports a versatile course structure, enabling students to learn anytime, anywhere.

The study seeks to accomplish the following goals:

1. Conducting a thorough bibliometric analysis to understand the nuances of digital transformation in the education sector.
2. Exploring the initiatives implemented by the Indian government to facilitate and streamline digital transformation in the country's education sector.
3. Investigating the challenges of digital transformation in the education sector.

1. Conducting a thorough bibliometric analysis to understand the nuances of digital transformation in the education sector.

The evolution of digital transformation research in education reflects a journey from early experimentation

to sophisticated exploration of transformative technologies. Initially, research focused on integrating basic digital tools like computer-assisted instruction and online platforms to enhance traditional teaching methods. As technology advanced, the research expanded to include interactive multimedia content, e-learning platforms, and emerging technologies like virtual reality. Recent focus intensified on holistic digital transformation, exploring AI, data analytics, and cloud computing to reshape pedagogical approaches and student outcomes.

In recent years, the focus has intensified on the holistic concept of digital transformation, reflecting a profound restructuring of educational processes and systems. Research now delves into the integration of artificial intelligence, data analytics, cloud computing, and adaptive learning technologies. Moreover, there is a growing interest in examining the societal and equity implications of digital transformation in education. Researchers are investigating issues related to digital literacy, the digital divide, and the impact of technology on educational access and inclusivity.

As education systems globally grapple with the challenges and opportunities posed by digital transformation, research has evolved to provide insights into effective strategies, best practices, and potential pitfalls. The evolution of digital transformation research in education is marked by an increasing recognition of the need for interdisciplinary collaboration.

Looking ahead, the trajectory of digital transformation research in education is likely to continue evolving, with an emphasis on longitudinal studies, in-depth qualitative investigations, and a nuanced exploration of the socio-cultural dimensions of technology integration in diverse educational settings. This evolution reflects the ongoing commitment to harnessing the potential of digital technologies to enhance the quality, accessibility, and inclusivity of education on a global scale.

Methodology

Descriptive bibliometric analysis

Conducting a descriptive bibliometric analysis is the focal point of this study, aiming to illuminate key characteristics within our dataset related to the digital transformation of the education sector. This includes:

a. Identifying frequently cited papers and examining citation distribution over the years.

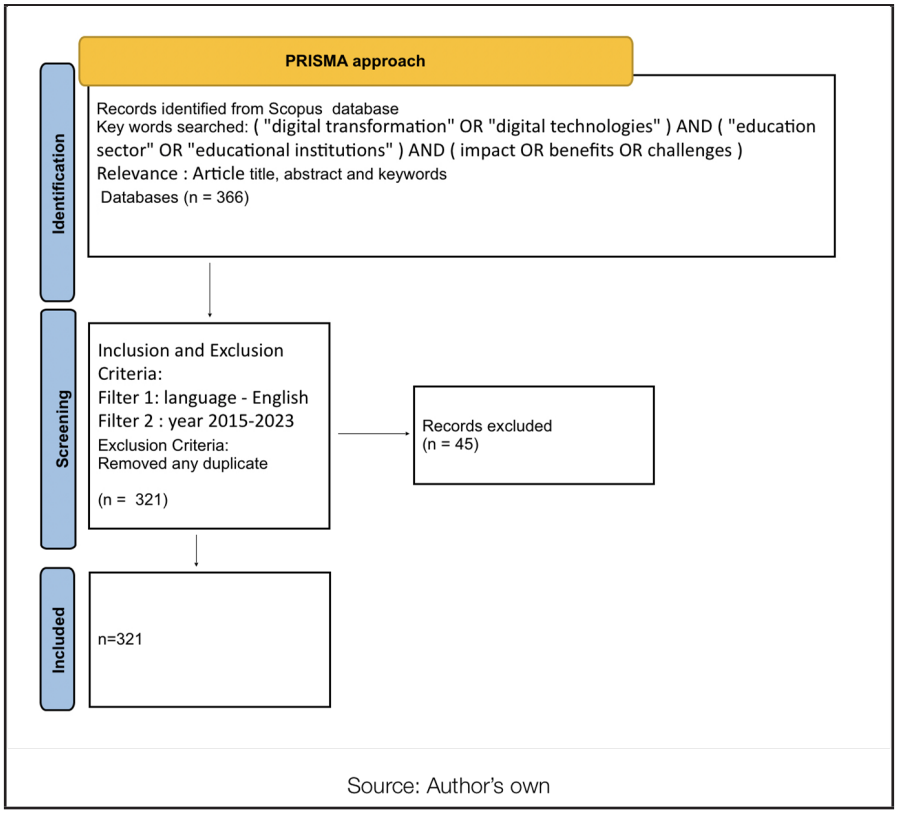
b. Analysing citations by year to highlight the most cited documents.

c. Investigating keyword co-occurrence to understand interconnected themes in the literature.

Bibliometric analyses

This article utilises a meta-review approach with the objective of synthesising the comprehensive body of completed and documented work conducted by researchers. Meta-reviews are acknowledged as effective methods for aggregating literature and exerting a substantial impact on research, practice, and policy. The Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) further advocates for the use of meta-review as it facilitates the exploration of new ideas, concepts, and debates in a critical, rigorous, and transparent manner.

Figure-1: PRISMA Approach



The search was conducted in Elsevier's Scopus on January 4, 2024. This search combined the terms ('digital transformation' OR 'digital technologies' AND ('education sector' OR 'educational institutions') AND ('impact' OR 'benefits' OR 'challenges') in the Title-Abstract-Keywords (TITLE-ABS-KEY) to identify manuscripts within the research area from 2015- 2023 (identification phase). Subsequently, pre-selected filters (i.e., language, source, and document type) were applied during the screening phase to identify the most relevant manuscripts. The next phase included accessibility criteria (eligibility phase), involving the removal of duplicated articles and those not strictly related to the topic. Incorporating additional articles helped to justify and/or reinforce the arguments used in the results section. Articles, conference papers, book chapters etc. were also considered relevant and not excluded. Careful attention to transparency, led us to include the flowchart (Figure 1) and its respective explanation. As mentioned earlier, data collection in the Scopus databases was carried out from 2015 to 2023. The database was selected because it is considered the largest international and multidisciplinary research database of peer-reviewed manuscripts.

After performing the search using the terms ('digital transformation' OR 'digital technologies' AND ('education sector' OR 'educational institutions') AND ('impact' OR 'benefits' OR 'challenges' in the TITLE-ABS-KEY, 366 manuscripts were identified. Following this, filter by full-text journal articles was applied to obtain high-quality research articles from the year 2015 -2023 and obtained 353 articles. For

readability and interpretation reasons, only articles in English were selected, as difficulties in interpretation could lead to biased results. This phase resulted in the selection of 321 scientific journal articles. The PRISMA protocol that was followed uses the same process of identification, screening, eligibility, and inclusion.

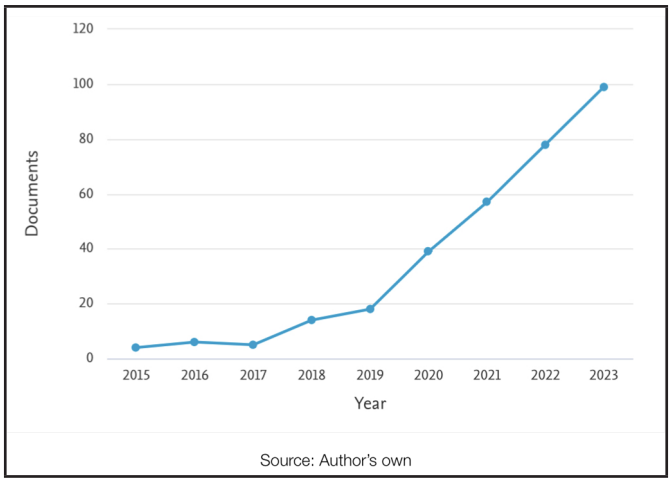
In this study, indicators of scientific production were utilised, including the distribution of analysed documents by the year of publication, keyword co-occurrence and cited papers. To achieve this, the software tool VOSviewer was employed for mapping. This tool facilitated the processing of keywords and the grouping analysis, with the objective of visualising maps based on co-authorship and co-occurrence. Additionally, VOSviewer unveiled indicators of collaborative structure, assessing network links among authors, institutions, and countries, and identified research trends based on the use of keywords.

Findings

a. Year wise description of 321 documents

The bibliometric analysis of the publication trend for research papers on digital transformation in the education sector reveals a notable evolution over the years. In the initial period from 2015 to 2019, the subject attracted limited attention, with only four research papers published in 2015. The interest gradually grew, reaching fourteen papers by 2018. However, the real turning point occurred in 2019, signalling a substantial surge in interest and recognition. In that year, 18 research papers were published, and this upward trend continued with 39 papers in 2020, 57 in 2021, and 78 in 2022. The peak of this surge was observed in 2023, with an impressive 99 research papers dedicated to the subject (Figure 2). This exponential increase in publications underscores the growing importance and relevance of digital transformation in the education sector.

Figure-2: Year wise publishing documents



Source: Author's own

It is crucial to acknowledge that this burgeoning interest can be attributed to influential articles published in earlier years, laying the groundwork for subsequent research endeavours. Additionally, the COVID-19 pandemic acted as a catalyst, accelerating the realisation of the imperative need for the education sector to embrace digital transformation. The pandemic

prompted a swift shift towards online learning, amplifying the urgency and relevance of research in this domain. As a result, the combination of seminal articles, increased awareness, and the transformative impact of the pandemic contributed to the remarkable growth in research publications on digital transformation in the education sector.

b. Citations by year and most cited documents

Authors	Title	Year	Cited by
De' R.; Pandey N.; Pal A.	Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice	2020	509
Mhlanga D.; Moloi T.	COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa?	2020	176
Sá M.J.; Serpa S.	The covid-19 pandemic as an opportunity to foster the sustainable development of teaching in higher education	2020	96
Laurillard D.; Kennedy E.; Charlton P.; Wild J.; Dimakopoulos D.	Using technology to develop teachers as designers of TEL: Evaluating the learning designer	2018	59
Coghlan S.; Miller T.; Paterson J.	Good Proctor or "Big Brother"? Ethics of Online Exam Supervision Technologies	2021	53
Abad-Segura E.; González-Zamar M.-D.; Luque-de la Rosa A.; Cevallos M.B.M.	Sustainability of educational technologies: An approach to augmented reality research	2020	50
Scully D.; Lehane P.; Scully C.	'It is no longer scary': digital learning before and during the Covid-19 pandemic in Irish secondary schools	2021	48
Anthony Jnr B.; Noel S.	Examining the adoption of emergency remote teaching and virtual learning during and after COVID-19 pandemic	2021	45
Rof A.; Bikfalvi A.; Marquès P.	Digital transformation for business model innovation in higher education: Overcoming the tensions	2020	40
Khitskov E.A.; Veretekhina S.V.; Medvedeva A.V.; Mnatsakanyan O.L.; Shmakova E.G.; Kotenev A.	Digital transformation of society: Problems entering in the digital economy	2017	38

The number of citations provides a sense of the documents' applicability to a

certain subject of study. Table 1 displays the total number of citations per article every year, taking into account the maximum and average total citations. This graph specifically emphasises the most referenced article each year as well as the year in which the papers are on average more cited. This analysis, which is constrained to citations that are present in our data set, enables us to determine the years in which the average accurately reflects the impact of the papers and the years in which it is distorted by the presence of a single paper with a large number of citations but other documents that join it with few citations. This happened in the year 2020, in which most cited papers with a number of citations were much higher than average. In Table 1, about the top 10 cited papers, the first paper, although first published, has 509 citations. The theme of the paper revolves around the profound impact of the COVID-19 pandemic on the increased use of digital technologies worldwide. As social distancing norms and lockdowns became ubiquitous, individuals and organisations globally had to adapt to new ways of work and life. The paper explores the various scenarios arising from this digital surge and delves into key research issues that have emerged. The transition to work-from-home is a significant aspect, leading to a heightened relevance of blockchain technology with implications for design and regulations. The rise of the gig economy presents research challenges related to work allocation, collaboration, motivation, and issues like work overload and presenteeism. Workplace monitoring and technostress issues gain prominence as digital presence increases. The paper anticipates a growth in online fraud, necessitating research on security management. Regulatory aspects of the internet post-pandemic become crucial, including addressing the consequences and causes of the digital divide. Net neutrality and zero-rating plans are identified as areas deserving scrutiny. Additionally, the paper emphasises the research imperative on the impact and consequences of internet shutdowns employed by countries. The role of digital money in crisis situations is highlighted, prompting research into adoption, consequences, and modes of digital currency. Surveillance and privacy concerns are underscored as significant considerations in the face of heightened digital usage. Overall, the paper provides a comprehensive overview of the multifaceted implications and research avenues arising from the increased reliance on digital technologies during the COVID-19 pandemic.

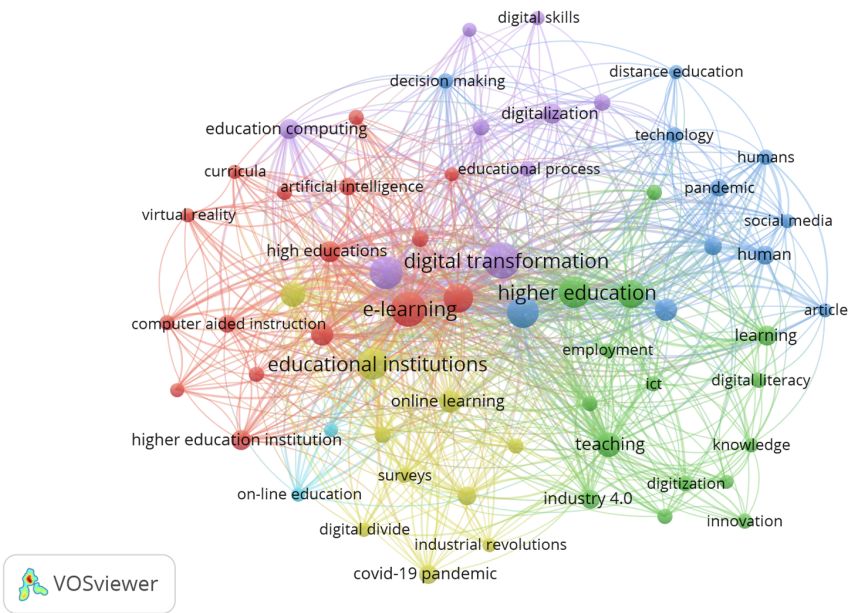
The second paper (with 176 citations) is the central theme of this study is the examination of the influence of the COVID-19 pandemic on motivating digital transformation within the education sector in South Africa. Prompted by the widespread disruption caused by the pandemic and subsequent lockdown, the study focuses on assessing the adoption of Fourth Industrial Revolution (4IR) tools in educational institutions during this period. Utilising data obtained from secondary sources, the findings reveal a significant surge in the use of 4IR tools across all levels of education, from primary to higher and tertiary education, as institutions transitioned to remote (online) learning. The study emphasises that South Africa, despite facing challenges in access to education, demonstrated pockets of excellence in driving the education sector towards the 4IR, potentially addressing issues of limited access, particularly at higher education levels. While acknowledging the widespread human suffering caused by the pandemic, the study highlights the unprecedented opportunity it presented to evaluate the successes and failures of deployed technologies, their associated costs, and the potential for

scaling these technologies to improve access to education. The findings contribute valuable insights for shaping the future of education in the context of digital transformation. The other most cited papers, in Table 1, have fewer citations (from 38 to 96).

c. Keywords network visualisation and cluster analysis

The keyword network map provided by bibliometric analysis stands out as a valuable tool, offering insights into the usage patterns and preferences of researchers regarding keywords. Through this map, a comprehensive understanding of the chosen keywords is gained, identifying the ones favoured by researchers and uncovering the network connections that link these preferred keywords.

Figure-3: Keywords Co-occurrence Visualisation



Source: Author's own

When analysing studies on digital transformation and education in the Scopus database, 1644 different keywords were identified. The most preferred keyword is "e-learning," as depicted in Figure 3. It is believed that the keywords presented in Figure 3 will offer valuable insights to researchers regarding current trends in studies related to digital transformation in the education sector. The network map shown in Figure 3 was generated by considering publications that utilised at least five keywords, resulting in 63 publications meeting this threshold and forming six clusters. The five keywords with the highest link strength are e-learning (327), educational institutions (245), digital transformation (225), digital technologies (205), and covid-19 (189). Additionally, the network analysis revealed the presence of six clusters.

Red Cluster: Artificial Intelligence and Education Technology

This cluster contains 16 keywords focusing on the intersection of artificial intelligence and education technology, emphasising their use in educational settings, especially higher education. Sadiku et al. (2021) describe artificial intelligence as enabling computers to perform human functions like thinking and learning, revolutionising teaching in classrooms and schools. The study explores various AI applications in the classroom. Similarly, Huang et al. (2023) highlight the impact of new technologies on teaching and learning, with AI's rapid progress evident in education. The article discusses AI's use in virtual classrooms, adaptive learning, and educational assessment, improving instruction and learning quality. References to AI supporting educational reform are provided, alongside potential challenges AI applications in education may face in the future.

Green Cluster: Digital Literacy, Education 4.0, and Innovation

This cluster contains 15 keywords and focuses on digital literacy, innovation in education, and technology integration (Education 4.0) for improved learning outcomes and addressing contemporary educational challenges. Frank (2017) elaborates on Digital Literacy as crucial for education, emphasising the need for learners to critically evaluate information sources. Despite widespread digital content, there are challenges in determining content legitimacy and authenticity. To navigate the digital world effectively, students must be taught digital literacy. Today's digital era has replaced traditional media with electronic text, television, and the internet. Lankshear (2015) explores various digital literacy concepts and their relation to information literacy, computer literacy, media literacy, functional literacy, and digital competence. He highlights the diverse aspects and benefits of digital literacy. Chan (2017) investigates digital concepts and techniques for developing digital literacy, emphasising its importance in education, work, and social life.

Blue Cluster: Decision Making, Technology, and Pandemic

This cluster includes 11 keywords focusing on decision-making processes, the impact of digital technology on education, distance education, and the influence of the COVID-19 pandemic on educational practices. Challenges exist in teaching and learning in the twenty-first century, requiring adaptation to digital resources. Information literacy and technology proficiency are essential for learners engaging with digital media, challenging traditional literacy methods. The McKinsey and Company Report (2017) emphasises the necessity of trade-off decisions for successful digital transformation. Similarly, Korherr (2022) suggests four management archetypes based on interviews with top executives from Germany, clarifying their traits, skills, and roles: Strategist, Coach, Guide, and Analytical Thinker.

Yellow Cluster: COVID-19 effect on Digital Education

This cluster includes 10 keywords and focuses on the impact of the COVID-19 pandemic on education, particularly digital education, online learning, and challenges related to the digital divide. Gandhi, Anju, and Rani, Kavita (2020) highlight the emergence of new educational approaches during the pandemic, such as teaching via social media, digital platforms, and cloud-based video communication platforms. They summarise the significant shift in technology use for teaching and learning during the pandemic. The

study assesses the positive and negative effects of the COVID-19 pandemic on education, including the discussion of digital programs launched by the Indian government to ensure continued education during lockdowns, such as Diksha, SWAYAM, Vidya Daan, E-Pathshala, Swayam Prabha, and National Repository of Open Educational Resources (NROER). Dashtestani and Hojatpanah (2020) emphasise how the pandemic exposed digital deficiencies in education, particularly in higher education, where new techniques and resources like digital platforms, simulation-based learning, video conferencing, and collaborative learning were not equally distributed. The digital divide also significantly impacted secondary schools.

Purple Cluster: Digital Skills and Transformation in Education

This cluster comprises 9 items and underscores digital skills, educational transformation through technology, and the integration of digital technologies across the education sector. Digital literacy skills are essential for effective learning in modern digital environments. Rêgo et al. (2023) aims to understand how Digital Transformation (DT) has impacted educational methods, necessitating a new professional profile. It examines the most in-demand skills and identifies opportunities for future experts. Additionally, it explores whether academic institutions have incorporated the new competencies demanded by the DT-affected job market.

Light Blue Cluster: Online Education Systems

This cluster includes 2 keywords and revolves around online education systems, indicating a focus on the structure, design, and implementation of education systems delivered through online platforms. Tadesse (2020), review the impact of the COVID-19 pandemic on the education system in developing countries. He highlighted that after COVID-19, the educational institutions had to re-design strategies and methods to recover lost learning, preparing students, parents, and teachers, and to scale distance learning accessibility.

These thematic clusters provide a comprehensive overview of the diverse topics covered in the analysed literature, allowing for a more nuanced understanding of the interconnectedness of keywords within each cluster.

2. Exploring the initiatives implemented by the Indian government to facilitate and streamline digital transformation in the country's education sector.

In recent years, India has witnessed a remarkable transformation in the education sector, primarily driven by the adoption of digital technologies. The push for digitalisation in education has been catalysed by the Indian government's ambitious vision to make education more inclusive, accessible and future-ready. The COVID-19 pandemic further underscored the urgent need for robust digital infrastructure and innovative learning methods, revealing both the potential and the gaps within the system. In response, the Indian government has launched a series of initiatives aimed at integrating digital tools, platforms and pedagogies across all levels of education. Central to this transformation is the National Education Policy (NEP) 2020, which serves as a comprehensive roadmap for reimagining education in India through digital empowerment.

NEP 2020 marks a paradigm shift in India's approach to education, placing strong emphasis on technology as a key enabler of quality and equity. It

envisions the use of digital tools not just as supplementary aids, but as foundational elements in the teaching-learning ecosystem. One of the policy's core pillars is the promotion of digital learning to bridge the urban-rural divide, enhance teacher training, foster personalised learning and support lifelong education. It highlights the creation of digital content in regional languages, development of accessible platforms for learners with disabilities and integration of emerging technologies like AI and data analytics into classrooms. Aligned with the goals of NEP 2020, the government has introduced several strategic initiatives such as DIKSHA, SWAYAM, e-Pathshala, PM e-Vidya and special e-Content for CWSN etc.

NEP 2020 not only recognises the transformative power of digital tools but also underscores the need for inclusive, ethical and learner-centric implementation. It calls for minimising the digital divide by ensuring access to internet connectivity and digital devices, particularly for disadvantaged groups. The government's holistic approach spanning infrastructure, content, capacity building and policy support underscores a long-term vision for an equitable and digitally empowered education system.

DIKSHA

DIKSHA (Digital Infrastructure for Knowledge Sharing) is a pivotal component of the PM e-Vidya initiative introduced under the Atma Nirbhar Bharat programme, representing the vision of 'one nation, one digital platform' for school education in India. Launched in 2017, DIKSHA serves as a national platform accessible to schools across all states and caters to students from grades 1 to 12. DIKSHA offers an extensive array of resources, including courses designed for teachers, quizzes, and a wealth of e-Content meticulously aligned with the curriculum (Ministry of Human Resource Development, 2020). Aligned with the NEP 2020, DIKSHA supports equitable and inclusive learning by providing flexible digital access to all learners, including students with special needs and teachers in remote areas. A significant addition to DIKSHA's repertoire is VidyaDaan, a content contribution program launched in April 2020. This inclusive approach encourages contributions from experts, private entities, and educational bodies, fostering a collaborative environment for the enhancement of digital education in India.

SWAYAM PRABHA

SWAYAM PRABHA, a distinctive mode of education, is specifically designed to cater to individuals who lack access to traditional educational resources. This initiative ensures that high-quality educational programs are telecasted through a total of 32 dedicated channels, strategically allocated to meet the diverse requirements of both higher education and school education. As emphasised by NEP 2020, such multi-platform delivery methods aim to bridge the digital divide by reaching learners in the remotest parts of the country. Recognising the importance of broadening the reach of educational content, the Department of School Education and Literacy has collaborated with private Direct-to-Home (DTH) operators such as Tata Sky and Airtel. This transformation aligns with the vision of 'one class, one channel,' where each grade from 1 to 12 will have a dedicated channel. This comprehensive approach underscores the commitment to democratising education and making it accessible to learners across diverse backgrounds and geographical locations.

e-Pathshala

The e-Pathshala mobile app, compatible with Android, iOS, and Windows platforms, along with its web portal, serves as a comprehensive platform for accessing e-textbooks. Designed to cater to students, teachers, and parents alike, this educational resource offers a diverse range of content, including 3,500 pieces of audio and video content from the NCERT. The platform's inclusivity is reflected in its availability in multiple languages, accommodating a broader audience by providing e-textbooks in English, Sanskrit, Urdu, and Hindi (Ministry of Human Resource Development, 2020). This accessibility and diversity make e-Pathshala a versatile tool for enhancing educational experiences across different linguistic and demographic contexts.

Radio Broadcasting

Radio broadcasting has emerged as a dynamic tool for fostering activity-based learning methods, engaging students through an interactive approach that enhances education. To facilitate this, 289 community radio stations broadcast content tailored to the National Institute of Open Learning (NIOS) curriculum for students in grades 9 to 12. This extensive network provides educational access to students in remote areas, democratising knowledge. A noteworthy initiative is the Shiksha Vani podcast launched by the CBSE, offering over 430 audio content pieces covering subjects from grades 1 to 12. This innovative use of radio broadcasting and podcasts promotes inclusive education, facilitating learning for students across grades and geographical locations.

SWAYAM

The NCERT plays a pivotal role as the National Coordinator for the development and dissemination of Massive Open Online Courses (MOOCs) dedicated to School Education, specifically designed for Classes IX to XII. Accessible through the "SWAYAM" (Study Webs of Active - Learning for Young Aspiring Minds) portal and mobile app, these courses aim to bridge the digital divide, providing educational opportunities to students who have been historically underserved students. As advocated by NEP 2020, the SWAYAM platform supports self-paced, quality learning through structured content including video lectures, reading material, self-assessment, and discussion forums. NCERT's commitment to these courses enriches students' learning experiences and aids them in achieving desired educational outcomes (Ministry of Human Resource Development, 2020).

Special e-Content for CWSN

Inclusive education for children with special needs is a priority, and various initiatives have been undertaken to ensure accessibility and support tailored to their specific requirements. Consistent with NEP 2020's inclusive education agenda, DIKSHA hosts audiobooks for visually impaired learners, facilitating their access to educational content. The NIOS is committed to inclusivity, making its website accessible to individuals with disabilities. The website incorporates diverse features such as display settings adjustment, ease of navigation, and enhanced content readability. NIOS employs the Digitally Accessible Information System (DAISY) standard, providing study material in digital audiobook format for visually impaired learners. An Indian Sign Language (ISL) dictionary aids communication and education for the deaf and hard-of-hearing learners. NIOS has produced over 270 sign language videos across seven subjects and a Yoga course, available on YouTube, offering educational access to learners

at the secondary level. Selected NIOS course content is recorded in sign language for hearing-impaired learners, available on both the NIOS website and YouTube. These recorded materials are further distributed to hearing-impaired students on DVDs, ensuring comprehensive educational support for children with special needs, reflecting a commitment to inclusive education and equal access to learning resources.

Investigating the challenges of digital transformation in the education sector.

Business entities, irrespective of their industry, encounter challenges when incorporating digital technologies into their established practices and procedures. In the case of education institutions, the process of digital transformation becomes more complex due to a number of problematic trends such as rise in operational costs, changing educational demands etc. Various challenges, including socio-economic disadvantages and financial limitations, impact students' academic performance. Even though comprehensive policies have been implemented to reduce educational gaps, certain students continue to face difficulties in completing their degrees due to various factors such as age, socioeconomic status, academic qualifications, and financial obstacles. COVID-19 has presented a new set of challenges in education institutions. The stakeholders have been compelled by these constraints to reconsider their approaches to teaching and learning in order to allow for more flexibility and to quickly address the complicated issues. The introduction of electronic initiatives in the teaching and learning processes in higher education institutions during COVID-19 has become a crucial catalyst for the change of education due to technological advancements.

Even though the impact of digital transformation on education is mostly positive and the benefit range is quite vast, there are still several challenges that act as an obstacle in the digital transformation of education institutes. The main strategic high-level challenges that higher education institutes usually face while adopting digital transformation are as follows:

Resistance to change

There is a widely accepted notion that the primary challenge faced by higher education institutions in embracing digital transformation lies in adapting to new teaching methods, learning settings, and models. Essentially, individuals tend to prefer the familiar and resist stepping out of their comfort zones, impeding progress and development. In the field of education, many harbour a fear of failure and are reluctant to acquire new skills or adapt to novel technologies, cultures, or mentalities.

To implement digital transformation in the education sector, instructors need the management and thinking ability of administrators to change. They need to explore possibilities in the virtual space and harness technology effectively. Implementing small pilot projects can offer a clear preview of potential changes, alleviating uncertainties and faculty concerns related to job security. Educational institutions must embrace knowledge and digital thinking to comprehend the boundaries and master technology.

Technology Infrastructure

In today's world, businesses and organisations rely heavily on technology for smooth operations and data security. Technical issues and lack of technical knowledge can lead to errors and dependencies. Investing in stable, secure, and scalable technology is crucial to prevent breakdowns. A

major challenge in education's digital transformation is the non-compliance with modern technologies, requiring upgrades or replacements of existing systems. Many educational institutions lack sufficient infrastructure for transformative learning. Updating technology infrastructure should be the initial focus to facilitate meaningful change. The education industry requires new equipment and technology infrastructure. Selecting a platform with easy access and efficient course creation is a challenge for educational institutes, highlighting the importance of technology infrastructure in fostering an engaging learning culture.

Lack of clear strategy

Understanding digital transformation direction is a major hurdle for progress. Mass change can be daunting, making it challenging to determine the right course of action or formulate an effective strategy. Adopting new technologies without a plan can lead to difficulties. Major educational institutions face challenges in utilising new technology for tasks, hindering learning and goal achievement. Robust strategies are essential to focus on objectives and achieve success.

The process of creating automated systems lacks a defined methodology. Employee dependence and high training expenses result from less user-friendly technologies. Administrators require outside support to modify procedures, causing delays. Developing a plan for technology integration in education is crucial, designed in stages with a tracking system for optimal effect. However, many educational institutions struggle to develop digitalisation strategies due to busyness or lack of technology knowledge, hindering desired outcomes.

Inferior knowledge or skills in utilising technology

Enough competence, trust, and abilities are necessary to foster innovation within the organisation. If educators lack the skills to use technology, digital transformation will fail. Thus, instructors must be updated with skills to guide students effectively. Students must also continually upskill to keep pace with evolving technology.

Helping students is the primary priority of teachers and administrative personnel. However, unfamiliarity with complex technology can hinder rather than aid learning. Therefore, institutions should organise frequent training programs for staff to ensure they remain proficient in navigating systems effectively.

Inequality in education

Given the expenses linked with contemporary technology, it is unlikely that every student could afford it. Digital equity can only be achieved by unrestricted access to technology, regardless of time or location. However, this may also make learning more unequally accessible to pupils from different backgrounds and geographic locations. For example, students located in rural or mountainous areas are facing difficulty accessing high-quality education and have limited resources available for study. It is, for this reason, that classrooms must give students access to all the resources in an accessible manner if the digital transformation is to succeed.

Conclusion

In conclusion, the evolution of digital transformation research in education reflects a dynamic journey from early experimentation with basic tools to a comprehensive exploration of transformative technologies. The surge in research publications, particularly post-2019, underscores the growing importance of digital transformation in

the education sector. Seminal articles and the COVID-19 pandemic acted as catalysts, accelerating the realisation of the imperative need for digital education. The bibliometric analysis provides insights into publication trends, citations, and impactful papers, emphasising the profound impact of the pandemic on digital education.

The keyword network map and cluster analysis reveal the diverse topics covered in the literature, offering a nuanced understanding of research trends. Initiatives in India exemplify government efforts to promote digital education, ensuring inclusivity and accessibility through platforms like DIKSHA, SWAYAM PRABHA, e-Pathshala, and innovative uses of radio broadcasting.

The digital transformation of education institutions faces multifaceted challenges, ranging from operational costs and changing educational demands to socioeconomic disparities and financial constraints. The shift to online learning, accelerated by the impact of COVID-19, has introduced a new set of uncertainties and complexities. While digital transformation brings positive impacts, including greater flexibility and efficiency, several key challenges hinder its seamless adoption. These challenges include resistance to change, inadequate technology infrastructure, a lack of a clear strategy, and insufficient knowledge or skills in utilising technology. Moreover, the issue of inequality in access to technology amplifies existing disparities among students. Overcoming these challenges requires a concerted effort to inspire a vision of digital maturity, invest in stable technology infrastructure, develop clear strategies, and ensure continuous training for educators and staff. Addressing these obstacles is essential to realising the full potential of digital transformation in shaping the future of education.

Looking ahead, the trajectory of digital transformation research in education is expected to continue evolving, with a focus on longitudinal studies, interdisciplinary collaboration, and exploring socio-cultural dimensions. The commitment to harnessing digital technologies for global education enhancement remains a priority for researchers, policymakers, and educators alike.

References

Chan, B. S. K., Churchill, D., & Chiu, T. K. F. (2017). Digital literacy learning in higher education through digital storytelling approach. *Journal of International Education Research (JIER)*, *13*(1), 1–16. https://doi.org/10.19030/jier.v13i1.9907

Dashtestani, R., & Hojatpanah, S. (2022). Digital literacy of EFL students in a junior high school in Iran: voices of teachers, students and Ministry Directors. *Computer Assisted Language Learning, 35*(4), 635–665. https://doi.org/10.1080/09588221.2020.1744664

De', R., Pandey, N., & Pal, A. (2020). Impact of digital surge during Covid-19 pandemic: A viewpoint on research and practice. *International Journal of Information Management*, 55(102171), 102171. https://doi.org/10.1016/j.ijinfomgt.2020.102171

Erazo, S., Nicolay Esteve-González, G., & Vaca, V. (2015). *Teaching and Learning in digital worlds: strategies and issues in higher education*.

Fellnhofer, K. (2018). Visualised bibliometric mapping on smart specialisation: a co-citation analysis. *International Journal of Knowledge-Based Development*, 9(1), 76. https://doi.org/10.1504/ijkbd.2018.090502

Fink, D. A. (2020). *Conducting Research Literature Reviews: from the Internet to Paper*. SAGE.

Gupta, S., University of North Florida, Bostrom, R., & University of Georgia. (2009). Technology-mediated learning: A comprehensive theoretical model. *Journal of the Association for Information Systems*, 10(9), 686–714. https://doi.org/10.17705/1jais.00207

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, 3, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Hennessy, E. A., Johnson, B. T., & Keenan, C. (2019). Best practice guidelines and essential methodological steps to conduct rigorous and systematic meta-reviews. *Applied Psychology. Health and Well-Being*, 11(3), 353–381. https://doi.org/10.1111/aphw.12169

Korherr, P., Kanbach, D. K., Kraus, S., & Mikalef, P. (2022). From intuitive to data-driven decision-making in digital transformation: A framework of prevalent managerial archetypes. *Digital Business*, 2(2), 100045. https://doi.org/10.1016/j.digbus.2022.100045

McCarthy, A. M., Maor, D., McConney, A., & Cavanaugh, C. (2023). Digital transformation in education: Critical components for leaders of system change. *Social Sciences & Humanities Open*, 8(1), 100479. https://doi.org/10.1016/j.ssaho.2023.100479

Mhlanga, D., & Moloi, T. (2020). COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa? *Education Sciences*, 10(7), 180. https://doi.org/10.3390/educsci10070180

Ministry of Education. (2020). National Education Policy 2020. Government of India. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Ministry of Human Resource Development. (2020). *National Education Policy 2020*. Government of India. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf

Mukul, E., & Büyüközkan, G. (2023). Digital transformation in education: A systematic review of education 4.0. *Technological Forecasting and Social Change, 194*(122664), 122664. https://doi.org/10.1016/j.techfore.2023.122664

Muralidharan, K., Shanmugan, K., & Klochkov, Y. (2022). The New Education Policy 2020, digitalization and quality of life in India: Some reflections. *Education Sciences, 12*(2), 75. https://doi.org/10.3390/educsci12020075

PM e-Vidya - children with special needs. (2024). Gov.In. Retrieved January 13, 2024, from https://pmevidya.education.gov.in/cwsn.html

Rêgo, B. S., Lourenço, D., Moreira, F., & Pereira, C. S. (2023). Digital transformation, skills and education: A systematic literature review. *Industry and Higher Education*. https://doi.org/10.1177/09504222231208969

Sinha, E., & Bagarukayo, K. (2019). Online Education in Emerging Knowledge Economies: Exploring factors of motivation, de-motivation and potential facilitators; and studying the effects of demographic variables. *International Journal of Education and Development Using Information and Communication Technology, 15*, 5–30.

Tadesse, S., & Muluye, W. (2020). The impact of COVID-19 pandemic on education system in developing countries: A review. *Open Journal of Social Sciences*, *08*(10), 159–170. https://doi.org/10.4236/jss.2020.810011

Tijani, O. K., Obielodan, O., & Akingbemisilu, A. (2020). Usable Educational Software: Teacher- educators' Opinion about Ọpón-Ìmọ̀ Technology Enhanced Learning System. *International Journal of Education and Development Using Information and Communication Technology*, 16, 88–106.

Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538. https://doi.org/10.1007/s11192-009-0146-3

Zhou, S., Tao, Z., Zhu, Y., & Tao, L. (2019). Mapping theme trends and recognizing hot spots in postmenopausal osteoporosis research: a bibliometric analysis. *PeerJ*, *7*(e8145), e8145. https://doi.org/10.7717/peerj.8145