DIGITAL RENAISSANCE: A COMPREHENSIVE EXPLORATION OF EDUCATION TRANSFORMATION - HOTSPOTS, MODELS, AND STRATEGIC APPROACHES

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Abstract

The digital transformation of education represents a contemporary shift towards leveraging modern information technology to revolutionize teaching methodologies, management systems, operational mechanisms, and security systems. This transformation is underpinned by the innovative integration of artificial intelligence virtual simulation technology and multi-modal data, fostering educational evolution, and ultimately enabling comprehensive, personalized, and accessible learning experiences. In alignment with this trajectory, China's educational modernization agenda, as outlined in 2019, underscores the imperative to accelerate educational reforms in the information age. Central to this mission is the creation of intelligent campuses and the development of integrated platforms that encompass smart teaching, efficient management, and seamless services.

This digital transformation of education exhibits distinctive characteristics, such as the transition from a two-dimensional educational landscape to a multi-dimensional one and a shift in teaching evaluation from broad assessments to precise measurements. In essence, it encompasses a transformation of educational paradigms, pedagogical methods, cognitive approaches, and technological innovations. The 2022 Ministry of Education directive on Teachers' Digital Literacy serves as a critical milestone, providing a structured framework encompassing digital awareness, technological proficiency, digital application, digital social responsibility, and professional expertise. This framework significantly propels the digital transformation and development of education, highlighting the establishment of vocational education digital campuses, information benchmarks, resource-rich teaching repositories, exemplary online courses, and virtual simulation training facilities. By grounding itself in addressing societal challenges, adhering to developmental trends, and aligning with the broader national modernization agenda, the digital transformation of education promises to enhance the efficiency and precision of educational governance.

Introduction

Digital transformation of education refers to the use of modern information technology to promote the innovative development of teaching mode, management system, operation mechanism and security system, deepen the innovative application of artificial intelligence virtual simulation technology, integrate multi-modal data with virtual simulation technology, promote the integration and innovation of education, and finally realize the comprehensive, free and personalized development of education. In 2019, China Education Modernization mentioned: "Accelerate the educational reform in the information age, build an intelligent campus, and make overall plans to build an integrated intelligent teaching, management and service platform [1]. The transformation of education digitalization mainly embodies the following characteristics: the educational ecology is from plane to three-dimensional; teaching evaluation is from extensive to accurate. In a word, the digital transformation of education involves the transformation of educational mode, educational method, educational thinking and educational technology [2]. In 2022, the Ministry of Education issued a notice on the education industry standard of Teachers' Digital Literacy, which sorts out the framework of teachers' digital literacy, including digital awareness, digital technology knowledge and skills, digital application, digital social responsibility and other professional fields, and effectively promotes the digital transformation and development of education. In the digital transformation of education, vocational education digital campus, information benchmark, professional teaching resource pool, excellent online open courses, virtual simulation training base and other information projects will be established. The digital transformation of education should reflect the solution of major social problems, conform to the trend of the times, stand at the high point of social development strategy, help realize the modernization of China, and the digital transformation of education will promote the efficiency and accuracy of education governance.

1.   Research hotspots and research trends

The literature data of this paper comes from WOS (Web of science) database, with the theme of "digital transformation of education" and the deadline of publication from January 1, 2015 to July 16, 2023, a total of 1381 articles were retrieved. In this paper, citespace6.1R6 is used for visual analysis, and the running time of the software is set as "2015-2023", K=25, and the pruning method is Pathfinder, annual pruning and overall network pruning. After running, the following graphs are obtained.

1.1   Network of research institutions

The cooperative network map of research institutions explains the spatial distribution of research forces in this field. In order to find the institutions that promote research development, this study uses the cooperative network analysis function in CiteSpace software tools to mine the network relations of research institutions in the research field. This network relationship can directly reflect the cooperation between institutions and provide reference for scientific evaluation of the influence of institutions within the academic scope. Using CiteSpace software to visually analyze the data, the Time Slicing of the software is set to "2015—2023", the yearsperslice is set to "1", k = 25, the node types panel selects "Institution", the pruning method is Pathfinder, and the other options are the default options of the system.

The cooperative institutions are analyzed from the perspective of time series by using tiomezone function. Running can get the network map of the distribution of educational digital transformation research institutions, as shown in Figure 1, in which the node size indicates the number of periodical papers published by the research institution, the connection line between nodes indicates the cooperation intensity between different institutions, and the color of the connection line represents the cooperation relationship in different time periods. Aalborg Univ, Gdansk Univ Technol and other institutions appeared earlier, distributed in 2016, and high-yield institutions were roughly distributed in 2017-2021, indicating that research institutions have a long time span and long research duration. And the color of most research institutions is mostly yellow, which shows that the research is high and the time is short, and the related research has a drastic change trend in this period, which is consistent with the trend of the number of papers published (the main conference policy documents in this period). Recent research

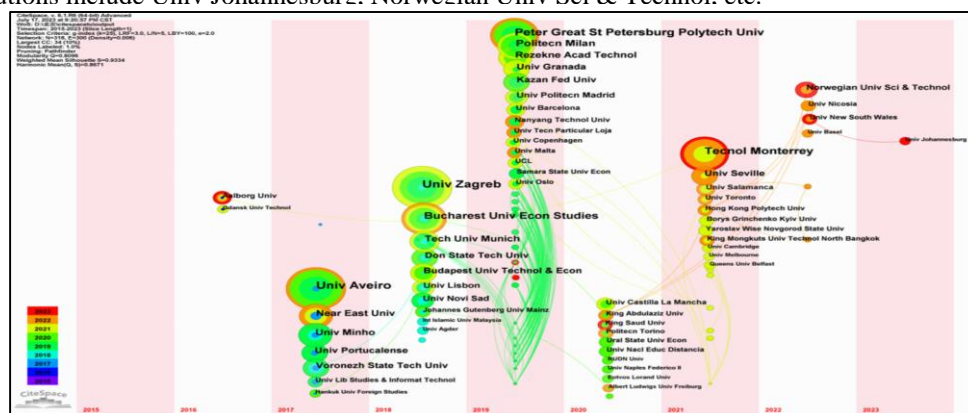institutions include Univ Johannesburg. Norwegian Univ Sci & Technol. etc.

Figure 1: Time Zone Map of Institutions

1.2 Keyword clustering

Research hotspot is the focus of scholars in a specific academic field, and it is also the embodiment of the main problems discussed in this field in a certain period. As an important part of academic papers, keywords condense the essence of papers and are often used to study and discuss hot issues in a certain field. Based on this, this paper uses CiteSpace software for clustering analysis of keyword co-occurrence to intuitively reflect the research focus of digital transformation of education. The keyword clustering view presented by Citespace is shown in Figure 2, and the color blocks represent the clustering areas. Node N=389, number of connections E=516, and network density Density=0.0068. The module value Q is related to the density of nodes. The larger the Q value, the better the clustering effect, which can be used for scientific clustering analysis. The size of the average contour value S can be used to measure the homogeneity of the cluster. The larger the value S, the higher the homogeneity of the network, indicating that the cluster has high credibility. As can be seen from Figure 2, Q=0.8081 (greater than 0.3), which shows that the clustering effect of the network structure is good; S=0.8748 (greater than 0.5), and the homogeneity is high, which shows that this cluster view is significant and reasonable, and different clusters are well divided. From the keyword clustering view, Formed #1primary education, #2digital health, #3educational innovation, #4industry 4, #5online learning, #6industry 4.0, #7big data, #8digital education, # 9higher education, #10digital transformation, #11virtual learning, #12media literacies, #13social media, a total of 13 clusters. The research on digital transformation of education mainly revolves around these clusters (see Figure 2). Among them, the figures show "primary education", "digital health" and "educational innovation". The average year of the top five clusters is from 2018 to 2021, which shows that the related research is mature in this period. Among them, the largest cluster is "primary education", and the year is 2019, which contains 38 keywords. To sum up, the research hotspots and research trends of digital transformation of education mainly include digital business, artificial

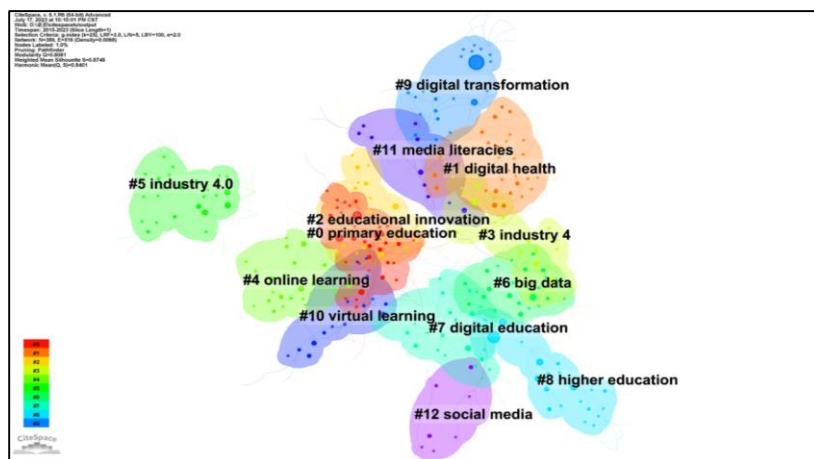intelligence, motivation, educational change and so on.

Figure 2: Keyword Clustering Map

Table 1: Keyword clustering map

Rank	cluster	Keywords	Average year	Keyword quantity
1	primary education	primary education ; digitalbusiness; artificial intelligence; motivation ; educational change	2019	38
2	digital health	digital health; internet of things ; stem ; machine learning ; saudi arabia	2021	34
3	educational innovation	educational innovation ; entrepreneurship education ; digital library; collaborative learning ; digital gender gap	2019	27
4	industry 4	industry 4 ; distance education ; digital learning ; digital literacy	2019	26
5	online learning	online learning ; architectural education ; circular economy ; medical education ; knowledge	2018	25

1.3 *Distribution of countries and regions*

In this paper, the node type of CiteSpace is set to Country, that is, the distribution of the research countries is analyzed, and the visual view spectrum of the cooperation network between countries/regions can be obtained as shown in Figure 3. Among them, the node size represents the number of papers published in this country, the connecting line between nodes represents the cooperative relationship between different countries, and the thickness of the connecting line represents the degree of cooperation. As shown in Figure 3, there are 112 nodes and 381 connections, and the overall network density is 0.0613, which shows that there are more countries studying the digital transformation of education and the cooperation between countries is closer. Among them, Russia is the largest research country, followed by Germany and Spain, and the cooperation network among countries is relatively close. Through the statistics of the number of papers published in different countries, the top ten high-yield countries in Table 1 can be obtained. From the perspective of centrality, there is a positive correlation between the number of articles published in most countries and the centrality, but the centrality of Russia, China and other countries is obviously not proportional, which shows that although the number of articles published is high, the centrality is low, and the cooperative relationship with other countries is not ideal. It is likely that there are problems in the citation of documents, which needs to be strengthened in the later period. To sum up, the cooperation networks among Russia, Germany and Spain are relatively close, and the research on digital transformation of education is more frequent and numerous.

Figure 3: Knowledge Map of Countries and Cooperation Networks
Table 2: Top Ten High-yield Countries

Rank	country	producing	centrality	Start year
1	RUSSIA	169	0	2015
2	GERMANY	135	0.03	2016
3	SPAIN	134	0.07	2015
4	USA	100	0.13	2015
5	PEOPLES R CHINA	97	0	2015
6	ENGLAND	75	0.03	2015
7	PORTUGAL	68	0	2015
8	ITALY	64	0.03	2016
9	AUSTRALIA	53	0	2015
10	ROMANIA	47	0.03	2016

## 2.	The ecological model

The ecological model of educational digital transformation refers to a visual ecological model used to simulate the interaction between digital system and artificial intelligence technology. Digital transformation of education is to use information technology and digital technology to promote the upgrading and transformation of education and teaching, and to explain the relationship between digital technology and data conversion and data simulation. The digitalization of education mainly embodies the following three types of transformation:

### 2.1	Technological transformation

The core level of digital transformation of education is technological transformation, which is mainly to determine the goal, make the plan and implement the technological transformation. Technical transformation is an architecture system that coordinates the efficient and stable operation of the technical system of the whole model, and cooperates with artificial intelligence technology, virtual simulation technology, internet plus, online education, big data, blockchain, Internet of Things, infrared sensing, ChatGPT and emotional computing to jointly maintain the model. According to the technical transformation plan, we will gradually implement technological upgrading and innovation to ensure the smooth progress of the transformation process. After the technical transformation is completed, it is necessary to evaluate the effect of the transformation, ensure that the effect of the new technology or method meets expectations, and solve the problems existing in the original technology or method.

### 2.2	Business transformation

Business transformation refers to the transformation and upgrading of educational business processes, teachers or systems to adapt to the changes in the information environment and improve the core competitiveness of education. There are three types of business transformation: operational transformation, core transformation and strategic transformation. Operational transformation refers to changing the operation mode of education, and education pays special attention to using digitalization, intelligence and technology to change educational problems. The core transformation refers to the fundamentally different operation modes of education. Strategic transformation is to transform the essence of education into an innovative field.

### 2.3	Literacy transformation

Literacy transformation is a comprehensive quality from focusing on students' knowledge learning to innovative thinking, problem solving, scientific and technological literacy and humanistic literacy. Literacy transformation embodies the transformation of educational concept, curriculum setting, projectbased learning and strengthening the cultivation of scientific and technological literacy. The transformation of literacy is mainly embodied in the improvement of teachers' information teaching ability and the transformation of teachers' information thinking. In the field of education, literacy usually refers to the comprehensive literacy of knowledge, skills, attitudes and values acquired by students through study and practice in school. From the perspective of information-based teaching environment, both school education goals and classroom teaching goals need to reconstruct new information literacy, focusing on cultivating students' comprehensive literacy such as innovation literacy, humanistic literacy and scientific literacy.
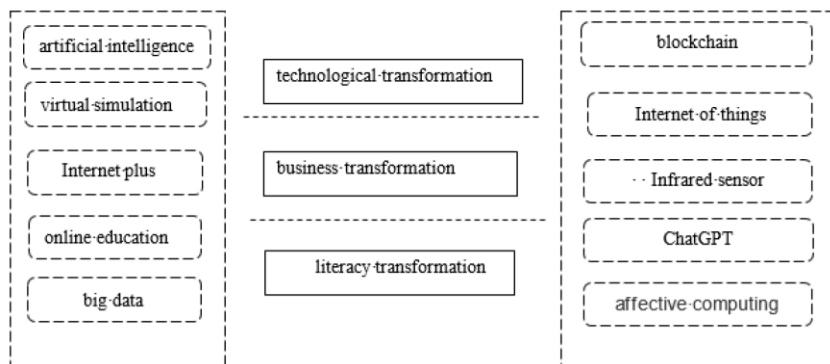
Figure 4: Ecological model of digital transformation of education

3. The research strategy

Digital transformation of education is a process of transforming traditional education methods by means of digital technology to improve education quality, promote education equity and realize the sustainable development of education. This process needs to comprehensively consider the policy environment, investment [3], infrastructure construction, digital educational resources, the quality of teachers and the reform of education and teaching. Here are some specific strategies:

3.1 Building a new infrastructure for digital transformation of education and promoting the highquality development of education.

The core level of education digital transformation is technology transformation, which is mainly to determine the goal of technology transformation, formulate technology transformation plan and implement technology transformation. Technology transformation is an architecture system that coordinates the efficient and stable operation of the entire model's technical system, and collaborates with artificial intelligence technology, virtual simulation technology, Internet +, online education, big data, blockchain, Internet of Things, infrared sensing, ChatGPT, emotional computing, etc., to maintain the model. After the technology transformation is completed, it is necessary to evaluate the effect of the transformation, ensure that the effect of the new technology or method meets the expectation, and solve the problems existing in the original technology or method.

3.2 Improve teachers' digital literacy skills training and improve teachers' digital technology ability.

Business transformation refers to the transformation and upgrading of education business processes, teachers or systems to adapt to the changes in the information environment and improve the core competitiveness of education. There are three types of business transformation: operational transformation, core transformation, and strategic transformation. Operation transformation refers to changing the mode of education operation, and education pays special attention to the use of digitalization, intelligence and technology to change education issues. Core transformation refers to the fundamentally different mode of operation of education. Strategic transformation is to transform the essence of education into an innovative field.

3.3 Building a diversified evaluation mechanism for the digital transformation of education to improve the accuracy of evaluation.

The transformation of literacy is from the focus on students' knowledge learning to the comprehensive quality of innovative thinking, problem-solving, scientific and technological literacy and humanistic literacy. Literacy transformation embodies the transformation of education concept, changes the curriculum, advocates project-style learning, and strengthens the cultivation of scientific and technological literacy. The transformation of literacy is mainly embodied in the improvement of teachers' information-based teaching ability and the transformation of teachers' information-based thinking. In the field of education, literacy usually refers to the comprehensive literacy of knowledge, skills, attitudes, values and other aspects acquired by students through learning and practice in school. In the vision of information-based teaching environment, both school education goals and classroom teaching goals need to reconstruct new information-based literacy, focusing on cultivating students' innovative literacy, humanistic literacy, scientific literacy and other comprehensive literacy.

In short, the digital transformation of education needs to comprehensively consider the policy environment, investment, infrastructure construction, digital educational resources, the quality of teachers and the reform of education and teaching, so as to achieve the goal of digital transformation of education.

4.   Conclusion

This study mainly explores the hot topics, ecological models and innovation strategies related to the digital transformation of education, and makes a visual analysis of the network of research institutions, keyword clustering, countries and regions in the digital transformation of education through citespace knowledge map software. The results show that the research hotspots and trends of digital transformation of education are Digital Business, Artificial Intelligence, Motivation, Educational Change, etc. The cooperation network among Russia, Germany and Spain is relatively close, and the research on digital transformation of education is more frequent and numerous. In the future research, we can use modern technology to evaluate the changing rules and innovative strategies of digital transformation of education, for example, big data and ChatGPT technology can accurately evaluate the mode of digital transformation of education.

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