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Artificial intelligence and digitalization in China's education system: A systematic analysis of the policy framework and underlying strategies

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INSTITUTE OF
EAST ASIAN STUDIES

XING LIU-SCHUPPENER

**Artificial Intelligence and Digitalization
in China's Education System.**

**A Systematic Analysis of the Policy
Framework and Underlying Strategies**

NO. 136

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**WORKING PAPERS
ON EAST ASIAN STUDIES**

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XING LIU-SCHUPPENER

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WORKING PAPERS ON EAST ASIAN STUDIES, NO. 136, DUISBURG 2023

Abstract

The People's Republic of China is generally considered a pioneer in the development and application of artificial intelligence methods and digitalization solutions. This article is dedicated to a systematic review of the current AI and digitalization strategy in the education sector in China and places it in the wider context. It examines China-specific education policy strategies, how they are shaped, and which actors are crucial in this regard. The study is based on a systematic evaluation of publicly available sources using software-supported document analysis. For this purpose, 48 thematically relevant policy documents from the period of 2001 to 2022 were included.

The results are categorized using an analysis framework and interpreted on the level of content as well as on the level of processes and relationships. The study thus provides an overview of the different phases and areas of education policy in China, central mechanisms of action, as well as political priorities and their changes over time.

Keywords

China, policy, education, strategy, informatization, digitalization, AI, document analysis

This article is based on results produced by the joint ChiKUBIG project which explores China-specific characteristics of the emergence of innovations in artificial intelligence and environmental protection at the Institute for Vocational Education and Adult Education, Prof. Dr. Steffi Robak, Leibniz University Hannover (Germany). The project is funded by the German Federal Ministry of Education and Research (BMBF).

1 INTRODUCTION

1.1 STARTING POINT AND EDUCATIONAL POLICY DEVELOPMENTS

Digitalization in general and the technology complex of artificial intelligence (AI) in particular are developing rapidly and gradually permeating almost all areas of life. At the national level (and in the sense of an innovation system) education is the most important prerequisite for ensuring technological connectivity (see HolonIQ 2019).

Internationally, individual countries are developing and pursuing their own strategies to address these challenges, influenced by their national contexts (see HolonIQ 2019). According to the OECD, there are over 800 AI initiatives from 60 countries, most related to education (see OECD. AI 2021). However, the use of AI in education is not only a necessity to keep up with technological advancements, it is also a key for achieving the Sustainable Development Goals (the so called SDG 4), as stated by UNESCO. This is because it is central to inclusive, equitable and quality education; as well as promoting lifelong learning opportunities for all (see United Nations 2015, p. 15; Miao et al. 2021, p. 5).

The People's Republic of China is regarded as a pioneer in the development and application of artificial intelligence processes and digitalization solutions in general. At the same time, China has the largest education system in the world. This article is dedicated to a systematic review of the current AI and digitalization strategy in China and places it in the wider context. The aim is to clarify how the education strategy is structured, what kind of China-specific characteristics exist, and which actors are involved.

When talking about education in the age of digitalization and AI in China, there are different terms for it. These include, for example: "Internet + Education" (Chinese: 互联网 + 教育), "TV University Model" (电大模式), "Dual Teacher

Model" (双师模式), "Artificial Intelligence Classroom" (人工智能课堂), "Internet + Technology + Education" (互联网 + 科技 + 教育), "Artificial Intelligence + Education" (人工智能 + 教育), "Online Education" (在线教育), "Network Education" (网络教育), "Smart Education" (智慧教育). Nevertheless, the term "Education Informatization," in the original "教育信息化", has established itself as an umbrella term in China¹ (see Lei 2018; Wang et al. 2019; iResearch 2019; Huang and Wang 2022). Although there is no official and unified definition of the term to date, according to Huang and Wang (2022) there is nevertheless a broad consensus on the terminology and the understanding behind it. According to them, education informatization is based on the use of modern information technology to promote the effectiveness and efficiency of education and to advance education reform and development. With this relatively broad definition, almost all subtopics and specific aspects (as well as the associated labels) can be subsumed. Education informatization is also considered to be of considerable importance to the entire education sector and, by extension, to society as a whole (cf. Huang and Wang 2022, p. 10). In other words, the development of education informatization cannot be understood only as an educational or technical task, but also includes important economic and social aspects.

China has made education informatization an essential strategic task and has issued numerous guiding documents and resolutions over the past 20 years to anchor it in education policy. In 1999,

¹ The term "education informatization" (Yan and Yang 2021) is a specifically Chinese linguistic construct without a comparable equivalent in German or English. Similar terms are, for example, e-education, network-based education, online education, cyber education, virtual education, etc. However, these terms are primarily focused on the properties of the objects. In contrast, educational informatization is a process term (see Huang and Wang 2022, p. 10).

the government document *Decision of the State Council of the Central Committee of the Chinese Communist Party on Deepening Education Reform and Comprehensively Promoting Quality Education* first proposed the term education informatization, which has since been widely used (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 1999, p. 874). In 2001, education informatization was officially established as a key point for China's educational development (see State Council of the People's Republic of China 2001, p. 30). In the same year, the *Tenth Five-Year Plan for National Education* issued by the Ministry of Education listed the "Education Informatization Project" as one of six education projects to be implemented during the plan period (see Ministry of Education of the People's Republic of China 2001, pp. 392–394). In 2002, the Ministry of Education published the *Tenth Five-Year Plan for the Development of Education Informatization* (see Ministry of Education of the People's Republic of China 2003b). In 2012, the Ministry of Education published the *Ten-Year Development Plan for Education Informatization (2011–2020)*, which defines the development goals and plans for China's education informatization for the next ten years (see Ministry of Education of the People's Republic of China 2012a). In 2018, the Ministry of Education issued the *Action Plan of Education Informatization 2.0* to further advance the development of education informatization (see Ministry of Education of the People's Republic of China 2018b). In addition, a series of policy documents have been successively promulgated to promote the development of education informatization in China from various aspects (see Section 2.1 for details). The above-mentioned national education policy documents were largely formulated by the national strategic leadership. Based on these guidelines, all provinces and cities of the country develop their own implementation concepts that are in line with local needs.

From the above, it is obvious that the Chinese government has paid great attention to the development of education informatization. There-

fore, in order to research the development of education informatization, it is important to first identify what kind of framework the government has created for its development. Against this background, this paper focuses on the analysis of the policy framework and the research question: What are China-specific policy strategies for the informatization of education? How are they shaped and which actors are involved?

1.2 SELECTED INSIGHTS INTO THE CURRENT STATE OF RESEARCH

The state of the art of research is reflected in particular in the form of publications. A useful indicator of the intensity of scientific activities can thus be found in the number of publications related to the topic. The CNKI (China National Knowledge Infrastructure) database, which is the largest database for academic works and electronic resources in China, as well as for Chinese literature as a whole, can serve as a basis for determining this indicator. Chinese government publications are also included in this database. Currently, more than 20,466 documents related to the keyword "educational informatization" (教育信息化) published between 1939 and 2022 are listed. For the keyword "educational informatization, policy" (教育信息化政策), 125 scientific publications could be identified (cf. <http://www.cnki.net/>; as of December 2022).

To gain insight into their content, a sample analysis of the 20 most cited scientific articles among these 125 publications was conducted (as of December 2022; see Appendix for the literature list of the sample analysis). The results of the analysis cover three main aspects:

- 1 The publication period of these 20 publications spans 2005 to 2019, with a peak in 2014, from which four publications originated. The three most common keywords are information technology (信息技术, $n = 11$), educational informatization ($n = 7$), and information technology in basic education (基础教育信息化, $n = 6$).

2 These 20 papers include not only studies on the informatization of education in China ($n = 11$), but also studies on the informatization of education abroad ($n = 9$). The key focus of the majority of the selected papers is educational theory and management, with almost 90 % concentrating on these topics. In terms of content, these focus primarily on national policy development and research, value analysis, macro-policy, and strategy research on the informatization of education. For example, policy (Hu 2011) and development (Jiao et al. 2014; Zhong et al. 2017) aspects are examined. There are also studies that focus on a specific area of education, such as basic education (Hu 2011; Liu 2016), which accounts for the largest proportion compared to other areas of education, or on a specific topic, such as teacher education (Du 2013), foreign language teaching (Wang 2017), and digital educational resources (Gao et al. 2019). A large proportion ($n = 9$) also focus on the study of

policies and strategies to promote the informatization of education in other countries (Cui et al. 2011; Zhang et al. 2017), and comparative studies between China and other countries (Zhou et al. 2014; Zhang et al. 2015; Wie et al. 2016; Wu et al. 2017).

3 From a methodological point of view, the vast majority of studies ($n = 13$) are qualitative content analyses. A few studies are quantitative ($n = 2$), e.g. word frequency analysis and surveys. The remaining five studies are conceptual in nature. In terms of scope, most of the studies were conducted on a small number of documents.

Overall, it can be said that there has been a lack of studies devoted to a systematic, document-based review and analysis of informatization on the national level. This is evident both in the sample conducted and in further research on the topic.

2 SPECIFICATION OF THE OBJECT OF STUDY

2.1 RESEARCH DESIGN

The study examines China's specific education policy strategies, how they are developed, and the key actors involved. In order to explore the subject of the study, a systematic evaluation of publicly available original sources will be carried out by means of document analysis. Document analysis is primarily used in social science research. Documents are "any objective evidence that can serve as a source for explaining human behavior" (Atteslander 1971, p. 53) and thus have the character of evidence. In China, policy documents are usually written in the form of plans, statements, circulars, minutes, resolutions, measures, etc., but also include textual forms such as speeches by leaders, development profiles, annual work priorities, reports, and so on. These can reflect policy direction over a period of time (see Section 2.2 for more information on

selecting policy documents). Following the approach of Hermanni (2021), the first step is the selection of the documentation area, followed by the categorization of a corpus of documents, the evaluation, a review of the relevant documents, and finally the discussion of the results.² For this purpose, original sources on the state level are consulted. In particular, freely available documents with a directive character from the archives of the Chinese Ministry of Education (http://www.moe.gov.cn/jyb_xxgk/). These docu-

² This method of document analysis was chosen because, first of all, the procedure makes the method of document analysis self-sufficient. "Without having to resort to further methods or models for data evaluation, systematic document analysis is suitable for the scientific study of communication material" (Hermanni 2021, p. 3). On the other hand, document analysis can be carried out efficiently with a mixed-methods approach in conjunction with the MaxQDA software.

ments provide access to policies and laws issued by the Ministry of Education, the Central Committee of the Communist Party of China, the State Council, and other state actors. Documents with a thematic focus on information technology (IT) and education are researched and included. In total, policy documents from 2001 to March 2022 were considered. Taking into account the nature of the documents and their relevance to the research topic, from a population of 120 published documents, 48 were classified as potentially relevant and selected for closer examination. The in-depth evaluation and processing is now carried out by means of a software-supported systematic document analysis. For this purpose, the documents are coded using an aligned category system (for more information on the category system, see Section 2.2) and transferred to a text analysis system (MAXQDA). This procedure follows a mixed methods approach.

2.2 DOCUMENTATION AREA

First, the documentation area for systematic document analysis must be selected, i.e. the population of documents, the type of documents, the period of document analysis, the number of analyses and the operationalization must be determined (see Hermanni 2021, p. 4).

In China, education policies are usually recorded in policy documents such as resolutions, decisions, programs, notices, reports, statements, and demands of the Party and the government; sometimes they are also published in Party newspapers, Party magazines, and editorials. The types and contents of China's education policy documents are extremely diverse. Following Su's (2016) systematization, we can distinguish between the following types: 1) Party policy documents, 2) education policy documents formulated and approved by the People's Congress, 3) education policy documents formulated and issued by state administrative organs, 4) education policy documents formulated and approved by the Party Central Committee and relevant departments of local Party leading organs at all levels in coop-

eration with the State Council and departments of local people's governments, and 5) speeches and instructions by Party and state leaders on education issues (see Su 2016, pp. 20–23).

Documents are selected according to the following principles to ensure the accuracy and representativeness of the policy document:

- 1 Education policy in China combines top-down governance with elements of an experimental bottom-up dynamic (see Liu-Schuppener 2022, pp. 432–434). That is, the state formulates the top-level blueprint from the national level. Local authorities then develop the relevant guidelines in accordance with the national regulations. Since the study in this paper focuses on the national level, this paper considers national-level education policy documents that are specifically set and implemented by the Chinese central government. Regional documents are not included.
- 2 The informatization of China's education system can be divided into three phases: the initial phase of education informatization (1978–2000), the phase of education informatization 1.0 (2001–2018), and the phase of education informatization 2.0 (since April 2018) (see Lei 2018, p. 102; Wang et al. 2019, pp. 4–6; iResearch 2019, pp. 10–11; Huang and Wang 2022, pp. 20–26). In the first phase, the informatization of education was still in its infancy and focused on teaching experiments on computers and computer-based instruction. In the latter two phases, modern information technology based on computers, multimedia, big data, AI, and network communication has been used more extensively in the educational process to promote educational reform and adapt to the new demands of the information society. Since this research focuses on educational innovation in the age of artificial intelligence, this paper is limited to the period from 2001 to 2022, which corresponds to the two phases of education informatization 1.0 and 2.0.

Based on these two: time and content criteria, 120 target documents were identified. These were then examined in more detail. Taking into account the type of documents and their rel-

evance to the research topic, 48 were finally classified as potentially relevant and used for a content review. Table 1 gives an overview of the documents.

Table 1: List of Chinese central government policies on education informatization

No.	Publication date	Document title and publisher
1	Nov 14, 2000	Notice on the Implementation of the School-to-School Connection Project in Primary and Secondary Schools ³ (see Ministry of Education of the People's Republic of China 2000)
2	May 29, 2001	Decision of the State Council on the Reform and Development of Basic Education (see State Council of the People's Republic of China 2001)
3	July 26, 2001	The Tenth Five-Year Plan for National Education (see Ministry of Education of the People's Republic of China 2001)
4	Sept 04, 2002	Education Informatization "Tenth Five-Year" Development Plan (Outline) (see Ministry of Education of the People's Republic of China 2003b)
5	Nov 27, 2002	Notice of the General Office of the Ministry of Education on the Printing and Distribution of the Implementation Measures of the "Education Management Information Standards" (Trial) and the Implementation Measures for the Construction of Demonstration Areas for the Application of the "Education Management Information Standards" (Trial) (see Ministry of Education of the People's Republic of China 2003a)
6	Mar 03, 2004	The State Council approved the Ministry of Education's "Action Plan for Revitalizing Education 2003–2007" (see State Council of the People's Republic of China and Ministry of Education of the People's Republic of China 2004)
7	Mar 19, 2006	Notice on Issuing the "2006–2020 National Informatization Development Strategy" (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2006)
8	May 31, 2007	The Outline of the Eleventh Five-Year Plan for the Development of National Education (see Ministry of Education of the People's Republic of China 2008)
9	July 29, 2010	Outline of the National Medium- and Long-Term Education Reform and Development Plan (2010–2020) (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2010)
10	Mar 13, 2012	Ten-year Development Plan for Education Informatization (2011–2020) (see Ministry of Education of the People's Republic of China 2012a)
11	June 14, 2012	The Twelfth Five-Year Plan for the Development of National Education (see Ministry of Education of the People's Republic of China 2012b)
12	Oct 09, 2012	Notice of the Ministry of Education and other eight ministries on the acceleration of the current key tasks to promote the informatization of education (see Ministry of Education of the People's Republic of China et al. 2012)
13	July 22, 2013	Notice of the Ministry of Education, the Ministry of Finance and the Ministry of Human Resources and Social Security on Further Strengthening the Informationization of Education Management (see Ministry of Education of the People's Republic of China et al. 2013)
14	Nov 16, 2014	Implementation plan for constructing an effective mechanism for expanding the coverage of high-quality educational resources by means of informatization (see Ministry of Education of the People's Republic of China et al. 2015)
15	June 07, 2016	Thirteenth Five-Year Plan for Education Informatization (see Ministry of Education of the People's Republic of China 2016)
16	June 12, 2016	Opinions on strengthening the construction of network security disciplines and personnel training (see Cyberspace Administration of China et al. 2016)

³ The time frame of the study actually begins in 2001, however this document was published in late 2000 and implementation began in 2001, so this document was also included in the study literature.

No.	Publication date	Document title and publisher
17	Jan 19, 2017	The 13th Five-Year Plan for National Education Development (see State Council of the People's Republic of China 2017b)
18	July 20, 2017	Development Planning for a New Generation of Artificial Intelligence (see State Council of the People's Republic of China 2017a)
19	Sept 05, 2017	Guiding Opinions of the Ministry of Education on Further Promoting the Development of Vocational Education Informatization (see Ministry of Education of the People's Republic of China 2017)
20	Dec 22, 2017	Guiding Opinions of the Ministry of Education on the Construction and Application of Digital Educational Resources Public Service System (see Ministry of Education of the People's Republic of China 2018c)
21	Jan 20, 2018	Opinions of the Central Committee of the Communist Party of China and the State Council on Comprehensively Deepening the Reform of Teacher Team Construction in the New Era (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2018)
22	Feb 12, 2018	Notice of the General Office of the Ministry of Education on Printing and Distributing the "Key Points of Education Informatization and Network Security in 2018" (see Ministry of Education of the People's Republic of China 2018d)
23	Mar 22, 2018	Five departments including the Ministry of Education issued the "Teacher Education Revitalization Action Plan (2018–2022)" (see Ministry of Education of the People's Republic of China et al. 2018)
24	Apr 03, 2018	Action Plan for Artificial Intelligence Innovation in Higher Education (see Ministry of Education of the People's Republic of China 2018a)
25	Apr 17, 2018	Notice of the Ministry of Education on Issuing the Guidelines for the Construction and Application of Online Learning Spaces (see Ministry of Education of the People's Republic of China 2018e)
26	Apr 18, 2018	Education Informatization 2.0 Action Plan (see Ministry of Education of the People's Republic of China 2018b)
27	Aug 08, 2018	Notice on Carrying out the Pilot Work of Artificial Intelligence Boosting the Construction of Teacher Teams (see Ministry of Education of the People's Republic of China 2018f)
28	Jan 16, 2019	Guiding Opinions of the Ministry of Education on Strengthening the Construction and Application of Online Learning Spaces (see Ministry of Education of the People's Republic of China 2019a)
29	Feb 23, 2019	China's Education Modernization 2035 (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2019a)
30	Feb 23, 2019	The Implementation Plan for Accelerating Education Modernization (2018–2022) (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2019b)
31	Mar 01, 2019	Notice of the General Office of the Ministry of Education on Printing and Distributing the "Key Points of Education Informatization and Network Security in 2019" (see Ministry of Education of the People's Republic of China 2019b)
32	Mar 21, 2019	Opinions on the Implementation of the National Primary and Secondary School Teachers' Information Technology Application Ability Enhancement Project 2.0 (see Ministry of Education of the People's Republic of China 2019d)
33	Aug 15, 2019	Opinions of Eight Departments Including the Ministry of Education on Guiding and Regulating the Orderly and Healthy Development of Education Mobile Internet Applications (see Ministry of Education of the People's Republic of China et al. 2019a)
34	Sept 25, 2019	Guiding Opinions of Eleven Departments including the Ministry of Education on Promoting the Healthy Development of Online Education (see Ministry of Education of the People's Republic of China et al. 2019b)
35	Nov 13, 2019	Notice of the General Office of the Ministry of Education on Printing and Distributing the "Administrative Measures for the Registration of Mobile Internet Applications for Education" (see Ministry of Education of the People's Republic of China 2019c)

No.	Publication date	Document title and publisher
36	Feb 24, 2020	Several Opinions on “Double First-Class” Construction of Colleges and Universities to Promote Discipline Integration and Accelerate Postgraduate Training in the Field of Artificial Intelligence (see Ministry of Education of the People’s Republic of China et al. 2020a)
37	Feb 26, 2020	Notice of the General Office of the Ministry of Education on Printing and Distributing the “Key Points of Education Informatization and Network Security in 2020” (see Ministry of Education of the People’s Republic of China 2020b)
38	Mar 05, 2020	Guiding Opinions of the Ministry of Education on Strengthening the Application of “Three Classrooms” (see Ministry of Education of the People’s Republic of China 2020a)
39	Sept 19, 2020	Notice of the Ministry of Education and other eight departments on printing and distributing the “Action Plan for Improving the Quality of Vocational Education (2020–2023)” (see Ministry of Education of the People’s Republic of China et al. 2020b)
40	Jan 20, 2021	Opinions of five departments including the Ministry of Education on vigorously strengthening the construction and application of online education and teaching resources in primary and secondary schools (see Ministry of Education of the People’s Republic of China et al. 2021c)
41	Mar 12, 2021	Notice of the Ministry of Education on Issuing the “Construction Standard of Digital Campus in Colleges and Universities (Trial)” (see Ministry of Education of the People’s Republic of China 2021a)
42	Mar 15, 2021	Notice of the Ministry of Education on Strengthening the Informatization of Education Management in the New Era (see Ministry of Education of the People’s Republic of China 2021b)
43	Apr 06, 2021	Notice of Ministry of Education and Six Other Departments on Strengthening Data Security in Education System (see Ministry of Education of the People’s Republic of China et al. 2021b)
44	July 08, 2021	Guiding Opinions of the Ministry of Education and Other Six Departments on Promoting the Construction of New Educational Infrastructure and Building a High-quality Education Support System (see Ministry of Education of the People’s Republic of China et al. 2021a)
45	Aug 04, 2021	Notice of the Ministry of Education and the Ministry of Finance on Implementing the Teacher Quality Improvement Plan for Vocational Colleges (2021–2025) (see Ministry of Education of the People’s Republic of China and Ministry of Finance of the People’s Republic of China 2021)
46	Mar 01, 2022	National Primary and Secondary School Smart Education Platform Construction and Application Scheme (see Ministry of Education of the People’s Republic of China 2022a)
47	Mar 10, 2022	Several Opinions of the Ministry of Education and Other Four Departments on Strengthening the Teaching Management of Online Open Courses in Ordinary Colleges and Universities (see Ministry of Education of the People’s Republic of China et al. 2022)
48	Mar 25, 2022	Notice of issuance of “Main focus of the work of the Center for Education Management Information (Ministry of Education) in 2022” (see Ministry of Education of the People’s Republic of China 2022b)

Own illustration

It should be noted that the publication of the *Education Informatization 2.0 Action Plan* officially marks the beginning of the education informatization 2.0 phase (see Ministry of Education of the People’s Republic of China 2018b; Wang et al. 2019, p. 6), therefore this paper uses the date of publication of this document as the dividing line between the two phases. Accordingly, documents #1–25 fall under the education informatization 1.0 phase, and documents #26–48 fall under the education informatization 2.0 phase.

2.3 CONCEPTION OF THE ANALYTICAL FRAMEWORK

Once the documentation area has been defined, the document corpus is categorized. This involves the development of a tree structure in the form of a category system.

The analysis and classification of policy instruments can provide information about the overarching strategy as well as about the actors and

the framework for action as such. One of the earliest systematic compilations of policy instruments was done by Kirschen (1964), who identified well over 40 different types of instruments. In later studies, scholars from different countries have conducted more extensive research on its classification. For example, McDonnell and Elmore (1987) define four general classes of policy instruments: Mandates, Incentives, Capacity Building, System Change. Schneider and Ingram (1990) develop a framework for analyzing the implicit or explicit behavioral theories in laws, regulations, and programs. In this framework, policy instruments are divided into five corresponding categories: Authority Tools, Incentive Tools, Capacity Tools, Symbolic and Hortatory Tools, and Learning Tools. In addition, there are numerous other approaches. For the following analysis, we build on a model by Rothwell and Zegveld (1981), which has a comparatively simple structure, but is aimed specifically at government innovation policy. They divide policy instruments into three categories (see Rothwell and Zegveld 1981, 1985, p. 84):

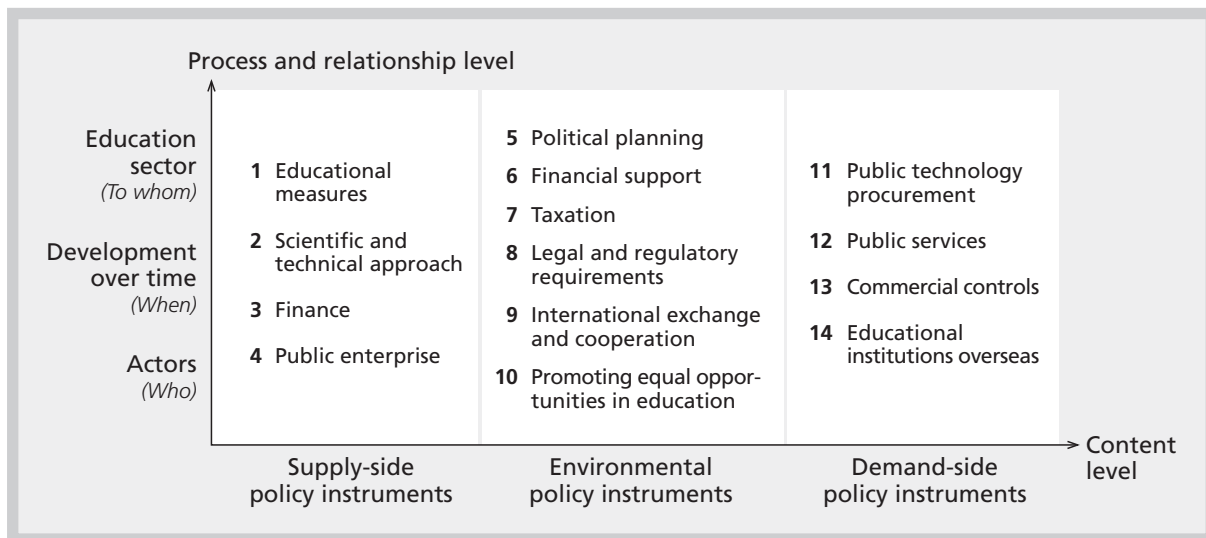
- Supply-side policy instruments include the provision of financial, human, and technical assistance, including the development of scientific and technological infrastructure, to support actors and enable them to act.
- Environmental policy instruments refer to the factors that determine the framework for action. These include, in particular, the legal framework and tax and patent policies.
- Demand-side policy instruments, on the other hand, refer to direct government intervention, such as public procurement, product subsidies, the creation of public offerings, and trade restrictions or facilitation.

Here, supply- and demand-based policy instruments played a direct role in promoting and accelerating the development of education policy, while environment-based policy instruments exerted an external influence (see Rothwell and

Zegveld 1985, p. 88). In this regard, the model seems particularly suitable for the object of study, as this classification is goal- and content-oriented and thus congruent with existing policy research (see Fan and Tang 2019, p. 149). Moreover, an important reason is that the model is aimed at promoting policy innovation (see Rothwell and Zegveld 1981). This framework is widely used in the analysis of policy documents (cf. Huang et al. 2007; Ning and Zhang 2014; Fan and Tang 2019; Zeng 2022). According to Rothwell and Zegveld, there are 12 subcategories⁴ under these three main categories (see Rothwell and Zegveld 1985, p. 84). Based on this initial subcategory, the selected documents are coded paragraph by paragraph. During the coding phase, the subcategories were adapted to the Chinese context, resulting in 14 subcategories (see Figure 1).

The subcategories are essentially based on the model of Rothwell and Zegveld (1981) and have only been marginally adapted to the application context. In addition, the financial category of the original model has been split into two subcategories, subcategories 3 and 6. Subcategory 3 – Finance – focuses on forms of financing the informatization of education, such as the establishment of special funds by the state. These are the supply-side policy instruments. Subcategory 6 – Financial support – on the other hand, is aimed at providing incentives for relevant companies or institutions to participate in the informatization of education. This is classified as an environmental policy instrument. The second difference is that the Scientific and Technical category and the Information category of the original model have been combined into the subcategory 2 – Scientific and technical approach – because they are very similar in content in this case. The third difference is that two additional codes, 9 and 10, were added to code the docu-

4 In detail: "Public enterprise, Scientific and technical, Education, Information, Financial, Taxation, Legal regulatory, Political, Procurement, Public services, Commercial, Overseas agent" (Rothwell and Zegveld 1981, 1985, p. 84).

Figure 1: Two-dimensional analytical framework for the China's education informatization policies

Own illustration based on Rothwell and Zegveld 1981, 1985, pp. 83–85

ments according to Chinese characteristics (see Section 3.1 for more information on the sub-categories).

The selected documents were coded according to these 14 subcategories and transferred to a text analysis system (MAXQDA) for analysis. In total, 1567 codes were assigned. With the help of these codes, on the one hand, it is possible to

analyze the content aspects of the documents in order to understand the government regulations for different aspects of educational informatization. On the other hand, the codes can be grouped by publisher, year, and educational field to analyze educational informatization at the process and relationship level. This resulted in a two-dimensional orientation of the analysis framework (see Figure 1) for the document analysis.

3 PRESENTATION OF THE RESULTS: POLICY FRAMEWORK FOR THE INFORMATIZATION OF EDUCATION IN THE PEOPLE'S REPUBLIC OF CHINA

According to the two-dimensional analysis framework, the evaluation is carried out on the content level (X-axis). This means that a detailed content overview of the documents is carried out from the perspective of the three main categories of supply-side, environment-side and demand-side educational measures. This is followed by an examination at the process and relationship level (Y-axis), i.e. from the perspective of the actors, the temporal context and the different educational domains. In this way, the framework of action created by the Chinese government for the development of educational informatization is examined.

3.1 CONTENT LEVEL ANALYSIS

As mentioned above, the selected policy documents were coded into three main categories with 14 subcategories (see Section 2.3). A statistical analysis of all codes shows that supply-side education policies are the most numerous, accounting for 52.55 % of all policies, followed by environment-related policies with 44.95 %, while demand-side policy instruments appear to be of little relevance with a share of 2.5 % (see Table 2). The Chinese government's political priorities can be inferred from this.

Table 2: Overview of the content analysis of the policy documents

Categories	Education informatization 1.0 (2001–2018)	Education informatization 2.0 (after 2018)	Total	1.0 to 2.0
Supply-side policy instruments	56.8 %	48.3 %	52.55 %	–8.5
Environmental policy instruments	40.8 %	49.1 %	44.95 %	+8.3
Demand-side policy instruments	2.4 %	2.6 %	2.50 %	+0.2
SUM	100.0 %	100.0 %	100.00 %	

Own illustration

Development trends in the three main categories can be identified solely on the basis of the chronology (time of publication). Compared to the phase of education informatization 1.0, the share of supply-oriented measures decreased by 8.5 percentage points in the phase of education informatization 2.0. However, it increased by 8.3 percentage points for environment-related measures. Demand-side measures remain almost unchanged and play only a very minor role (see Table 2). This change in trend implies

that the government has increased its activity in and focus on environment-related measures since entering the education informatization 2.0 phase.

In the following sections, each of the 14 subcategories are specified and analyzed through specific content analysis in the form of a qualitative study. Table 3 below summarizes the distribution of codes among the 14 subcategories. The findings are discussed below.

Table 3: Itemization of policy measures

Cat.	Subcategories (Policy tools)	Education informatization 1.0 (2001–2018)	Education informatization 2.0 (after 2018)	Total	1.0 to 2.0
Supply-side policy instruments	1 Educational measures	23.1 %	24.6 %	23.85 %	+1.5
	2 Scientific and technical approach	29.1 %	19.6 %	24.35 %	–9.5
	3 Finance	2.3 %	2.7 %	2.50 %	+0.4
	4 Public enterprise	2.3 %	1.4 %	1.85 %	–0.9
Environmental policy instruments	5 Political planning	24.0 %	22.8 %	23.40 %	–1.2
	6 Financial support	2.1 %	2.0 %	2.05 %	–0.1
	7 Taxation	0.2 %	0	0.10 %	–0.2
	8 Legal and regulatory requirements	10.9 %	20.4 %	15.65 %	+9.5
	9 International exchange and cooperation	1.6 %	1.2 %	1.40 %	–0.4
	10 Promoting equal opportunities in education	2.0 %	2.7 %	2.35 %	+0.7
Demand-side policy instruments	11 Public technology procurement	1.8 %	0	0.90 %	–1.8
	12 Public services	0	0.4 %	0.20 %	+0.4
	13 Commercial Controls	0.4 %	2.2 %	1.30 %	+1.8
	14 Educational institutions overseas	0.2 %	0	0.10 %	–0.2
	SUM	100.0 %	100.0 %	100.00 %	

Own illustration

3.1.1 SUPPLY-SIDE POLICY INSTRUMENTS

More than half of all codes can be attributed to supply-side education measures (see Table 2). Supply-side policy instruments include four sub-categories: 1) education, 2) scientific and technical approach, 3) finance, and 4) public services. The most frequently used policy instruments in this context were scientific and technical approach and education with 24.35 % and 23.85 % respectively, followed at a considerable distance by finance with 2.50 % and public services with 1.85 % (see Table 3). These figures make it clear that support for scientific and technical approaches and for education are top priorities for the government. In order of priority, the various subcategories are listed below for explanation.

Scientific and technical approach

Regarding the infrastructure necessary for the introduction of informatization in education, three main areas emerge from the document evaluation: Information Systems, Technology, and Science. “Information systems” refers to the government’s development of a basic information database for education informatization (e.g., information networks and centers, libraries, advisory and consulting services, databases, liaison services). Technology refers to a government-funded educational informatization platform or one built on the basis of existing platforms, as well as the linking and expansion of existing infrastructures (e.g., the basic configuration of school informatization, such as broadband network access, digital classrooms, quantity and quality of digital educational resources, informatization support platform). Science refers to measures taken by the government to strengthen research and development in education informatization (e.g., establishment of research laboratories, support for research associations, professional societies, professional associations, research grants).

In terms of time, the development of the infrastructure of education informatization 1.0 (2001–2018) can be further divided into the phase from

2001 to 2010 and the phase from 2010 to 2018. From 2001 to 2010, the introduction of information technology courses in schools and the launch of the “School-to-School Connection” program were the major measures to promote information technology in education (see Ministry of Education of the People’s Republic of China 2000; State Council of the People’s Republic of China 2001, p. 30). The goal of the program was to connect about 90 % of primary and secondary schools nationwide to the Internet within 5–10 years so that teachers and students could share educational resources online and improve the quality of education and teaching (see Ministry of Education of the People’s Republic of China 2000). The developments from 2010 to 2018 are mainly reflected in the construction of the so-called “Three Links and Two Platforms” (三通两平台). This was clearly stated in Chapter 19 of the *National Medium and Long-Term Education Reform and Development Plan (2010–2020)* as a specific goal of the entire education informatization 1.0 stage (see Central Committee of the Chinese Communist Party and State Council of the People’s Republic of China 2010, p. 13). In other words, the establishment of the so-called “Three Links and Two Platforms” is the central concern of education informatization 1.0. What exactly does this phrase mean? It is also clearly explained in government documents. The “Three Links” refer to the connection of schools to information and communication technology (ICT) (e.g., campus network, multimedia classrooms and tools), the connection of individual classes to ICT (e.g., in the form of a platform for live online teaching), and the connection of people to ICT (e.g., platforms for parent-school interaction, mobile teaching tools, smart campuses). “Two platforms” refers to the public service platform for educational resources and the public service platform for educational management (e.g., as a planning tool for schools and student-teacher information management) (see Ministry of Education of the People’s Republic of China et al. 2015, pp. 36–37; Ministry of Education of the People’s Republic of China 2018e). The subsequent *13th Five-Year Plan for the Development of National*

Education identified the combination of “Internet + Education” as a key strategy for promoting the informatization of education. As a result, by the end of education informatization 1.0 in April 2018, significant progress had already been reported, especially in terms of the construction and application of the “Three Links and Two Platforms”, the improvement of teachers’ skills in the application of information technology, the level of information technology and its integration in the delivery of education, and in the area of international reputation (see Ministry of Education of the People’s Republic of China 2018b, p. 118).

In the education informatization 2.0 phase, the focus is less on the technical requirements and more on the design and implementation, so that a change from design-centered to application-centered development takes place. Against this backdrop, the focus of education informatization 2.0 will then shift to solving existing problems. The central development goal by 2022 is called “Three Allrounders, Two Improvements, One Major” (三全两高一 大). Like the “Three Links and Two Platforms” mentioned above, this expression is a metaphor. The “Three Allrounders” refers to the teaching applications for all teachers, the learning applications for all students, and the construction of a digital campus for all schools. The “Two Improvement” represents the continuous overall improvement on the level of information application and information literacy for teachers and students. The “One Major” refers to the establishment of a major platform for “Internet + Education” (see Ministry of Education of the People’s Republic of China 2018b, p. 120). Subsequently, the government has issued a series of documents to implement this measure in detail based on the application.

In summary, education informatization 1.0 focused primarily on building infrastructure, disseminating educational resources, and building and connecting computer networks to enable widespread adoption of information technology by teachers, learners, and educational administrators. Education informatization 2.0 builds on

the achievements of phase 1.0, but now focuses on how to use these facilities and resources. Specifically, it looks at how modern information technologies such as big data and artificial intelligence can help to modernize the traditional education model and enable open sharing of digital educational resources.

Educational measures

The second major part of the supply-side policy instruments is the provision of educational measures. The aim is to train education participants (teachers, students, professionals and others) according to the requirements of education informatization, so as to improve the informatization ability of education participants. At the same time, the teaching and learning process will be improved, the education management system will be developed, and human resources will be provided for the further informatization of education. The state document also provides detailed information for different education sectors, i.e. primary and secondary education, higher education and vocational training. They are planned differently according to their respective characteristics (for more information, see Section 3.2.3).

The document analysis revealed a stronger focus on educational measures in education informatization 2.0, combined with a decrease in scientific and technical content (see Table 3). From this change it can also be deduced that the focus of education informatization 1.0 was more on “things and stuff”, especially on technical infrastructure. In phase 2.0, the focus is on how this hardware can be used and what benefits can be derived from it, i.e. the main users of this technology are, of course, the educational stakeholders. Therefore, it can also be said that education informatization 2.0 is more focused on “people”. Only through this can a broad impact of the new technologies and a long-term change in the education sector ultimately be achieved.

Finance & Public services

In contrast to the scientific and technical approach and the educational measures, the is-

sues of finance and public services are of much lower importance.

The area of public services focuses on various support services provided by the government to ensure the normal and proper progress of educational informatization. Specific measures covered in relevant documents include, for example, various practical applications and professional consulting services, the application of new techniques by public enterprises, the participation of private enterprises in educational informatization, the encouragement and support of universities to join forces with enterprises, industry associations, and scientific research institutions to form technological innovation alliances in the field of artificial intelligence (see Ministry of Education of the People's Republic of China 2012a, pp. 8–11, 2012b, p. 55; Ministry of Education of the People's Republic of China et al. 2015, p. 36).⁵

The area of finance focuses on forms of financing for the informatization of education, e.g., through the establishment of special funds. At the same time, different perspectives are considered, such as the impact of investment in a macroeconomic sense, investment models that take into account stakeholders, and the special needs for investment in education informatization in poor areas, such as the western regions of China, minority areas, and rural areas. According to the 2019 China's Education Information Industry Report, government investment accounts for about 70–80 % of the total market volume in education informatization (see iResearch 2019, p. 19).

3.1.2 ENVIRONMENTAL POLICY INSTRUMENTS

The importance of environmental policies is similar to that of supply-side policies (see Table 2). The environmental policy measures are divided into subcategories: 5) policy planning, 6) financial support, 7) taxes, 8) legal and regulatory require-

ments, 9) international exchange and cooperation, and 10) promotion of equal opportunities in education. Of these, policy planning accounts for the largest share at 23.40 %, followed by legal and regulatory requirements at 15.65 %, promotion of equity in education at 2.35 %, financial support at 2.05 %, international exchange and cooperation at 1.40 %, and tax incentives at 0.10 % (see Table 3). As in the previous section, a detailed content analysis of these subcategories will follow.

Policy planning, legal and regulatory requirements

The area of policy planning is central to ensuring an orderly process on the administrative level, while at the same time preparing, coordinating and linking implementation work on the operational level, and developing appropriate goals and efficiency and effectiveness benchmarks (e.g. in the form of guiding principles and working guidelines). The area of legal and regulatory requirements is closely related to this, but focuses on compliance aspects in order to establish and ensure legitimate, standardized and legal procedures for the development of educational informatization. For this purpose, the government issues, for example, administrative regulations, data protection regulations, evaluation index systems and evaluation methods to ensure that the informatization of education is carried out in a controllable, safe, orderly and stable state.

As shown in Table 3, policy planning and legal and regulatory requirements are of prominent importance; these areas manifest the government's top-down approach to promoting the development of educational informatization in an orderly manner. A comparison of the education informatization 2.0 phase with education informatization 1.0 shows that policy planning has decreased by 1.2 percentage points, while legal and regulatory requirements have increased by 9.5 percentage points (see Table 3). This may indicate that policy planning is particularly important in the initial phase, but that its importance decreases as the level of planning increases, and that implementation aspects and practi-

⁵ Of the 48 documents selected, 14 refer to this provision; accordingly, not all sources are cited here.

cal experience increasingly require regulatory measures. For example, the COVID-19 pandemic made it necessary to provide an Internet-based educational program for home schooling in a very short period of time. This relied heavily on the existing "Internet + Education" program. At the same time, this created entirely new problems and requirements in the area of data security and the protection of children and young people. In this context, the state issued a number of laws and regulations. As an example of this, the *Data Security Law of the People's Republic of China* was adopted at the 29th Session of the Standing Committee of the 13th National People's Congress of the People's Republic of China on June 10, 2021; on June 6, 2021, the State Council issued the *Opinions of the Leading Group of the State Council for the Protection of Minors on Strengthening the Protection of Minors*; and on 26th May 2022, the General Office of the Ministry of Education issued the *National Platform for Intelligent Education – Specification for Reviewing the Content of Digital Educational Resources (for Test Implementation)* in order to clarify the responsibilities for the administration, testing requirements, and supervision and evaluation of online resources on the intelligent education platform, and to ensure the content safety of digital educational resources (see Ministry of Education of the People's Republic of China 2022c). In addition to these specific documents, the topic is also defined in separate sections in other documents. For example, the *13th Five-Year Plan for Educational Informatization* lays down network security as one of the four development goals to define the next educational priorities.

Promotion of equal opportunities in education

Promoting equal opportunities in education is another aspect mentioned. China is an extremely large country, meaning that development varies greatly from east to west and from north to south. As a result, there are big differences in the educational situation and the level of knowledge about educational informatization in different regions. For the development of education infor-

matization in disadvantaged areas, the state will provide policy support, technical support and equipment support. Specific measures in this regard can also be found in the selected documents. For example, in 2000, the *Notice on the Implementation of the "School-to-School Connection" Project in Primary and Secondary Schools* mentioned that "the State will provide policy support for the implementation of the 'School-to-School Connection' project in poor areas." At the same time, society is actively encouraged to participate appropriately in the implementation of the project, especially by donating needed equipment to primary and secondary schools in remote and poor areas (Ministry of Education of the People's Republic of China 2000, p. 567). The *Tenth Five-Year Plan for the Development of Educational Informatization*, published in 2002, further supplemented the "School-to-School Connection" project in poverty-stricken areas (see Ministry of Education of the People's Republic of China 2003b, pp. 4–5). The National Strategy for the Development of Informatization 2006–2020 issued by the State Council of the Central Committee of the Chinese Communist Party in 2006 includes a plan to narrow the digital divide in the application of information technology between regions and between urban and rural areas in order to create a social environment with equal opportunities and coordinated development (see Central Committee of the Communist Party of China and State Council of the People's Republic of China 2006, p. 11). The *Education Informatization 2.0 Action Plan* also explicitly refers to special support for the development of education informatization in poorer areas, focusing on the "Three Areas and Three Prefectures" (三区三州)⁶

⁶ The "Three Areas and Three Prefectures" are areas of high poverty at the national level in China. The "Three Areas" refer to the Tibet Autonomous Region, the four southern prefectures of Xinjiang (Hotan, Aksu, Kashgar, and Kizilsu Kyrgyz Autonomous Prefecture), and Tibetan areas in Qinghai, Sichuan, Gansu, and Yunnan provinces. The "Three Prefectures" refer to the Liangshan Yi Autonomous Prefecture in Sichuan Province, the Nujiang Lisu Autonomous Prefecture in Yunnan Province, and the Linxia Hui Autonomous Prefecture in Gansu Province.

(see Ministry of Education of the People's Republic of China 2018b, p. 121). In other documents, such as the *Key Points of Education Informatization and Network Security in 2019*, the *Ministry of Education's Opinions on the Implementation of Project 2.0 to Improve the Application Ability of Information Technology for Primary and Secondary School Teachers*, support for the development of education informatization in poor areas such as the "Three Areas and Three Prefectures" was specified in various aspects.

International exchange and cooperation

Promoting international exchange and cooperation in the informatization of education also plays an important role in national overall planning. This means that the government promotes international exchanges and cooperation, actively supports and encourages enterprises in the field of informatization of education in China to go global, actively participates in international networks, and strengthens the international influence of Chinese education.

China integrates international cooperation in education informatization into the overall strategy of opening up education to the outside world. For example, the *National Strategy for the Development of Informatization 2006–2020* of 2006, the *Ten-Year Development Plan for Informatization of Education (2011–2020)* of 2012, the *Thirteenth Five-Year Plan for Informatization of Education* of 2016, etc., stipulate in various aspects that the development of the informatization of education and international cooperation is to be promoted. These include, for example, strengthening international exchanges, participating in the activities of international organizations in the field of education informatization, participating in the development of international standards, learning from advanced foreign ideas, learning from the introduction of foreign high-quality digital education resources and advanced technologies, or promoting the disclosure of education data.

Two specific features should be highlighted here. First, some documents emphasize that the de-

velopment of education informatization is to be actively intertwined with the education informatization needs of the countries along the "One Belt One Road"⁷ to intensify cooperation with these countries in particular. As an example for this, the 2017 *Development Plan for the New Generation of Artificial Intelligence* and the 2018 *Action Plan for Education Informatization 2.0* clearly indicate that, based on the "One Belt One Road" strategy, the establishment of international AI cooperation bases and joint research centers are to be promoted, and the application of AI technology in the "One Belt One Road" countries is to be accelerated (see State Council of the People's Republic of China 2017a, p. 19; Ministry of Education of the People's Republic of China 2018b, p. 125). Second, universities should be supported to strengthen international cooperation, make full use of talents, and actively promote the theoretical development and technological innovation in education informatization. For example, the *13th Five-Year Plan for the Development of National Education* and the *New Generation Artificial Intelligence Development Plan* of 2017, the *Action Plan for Innovation through Artificial Intelligence in Higher Education* of 2018, as well as *Several Opinions on the "Double First-Class" Construction of Colleges and Universities to Promote Discipline Integration and Accelerate Postgraduate Education in Artificial Intelligence* of 2020, clearly stipulated that universities should be encouraged to strengthen the construction of joint laboratories for international collaboration, organize academic conferences and forums on artificial intelligence with international influence, establish high-level academic journals, promote international science programs and projects, support

7 The "One Belt One Road" (Chinese: 一带一路) strategy has been applied since 2013 to the projects aimed at building and expanding intercontinental trade and infrastructure networks between the People's Republic of China and other countries in Africa, Asia and Europe. By December 7, 2022, China has signed more than 200 cooperation agreements with 150 countries and 32 international organizations to implement the "One Belt One Road" projects (see National Development and Reform Commission of the People's Republic of China).

international innovation collaboration in industrial technology, and actively integrate into global innovation networks (see State Council of the People's Republic of China 2017a, p. 19, 2017b, p. 54; Ministry of Education of the People's Republic of China 2018a, pp. 129–131; Ministry of Education of the People's Republic of China et al. 2020a, p. 61).

In addition, there are two other subcategories: as to financial support the government is encouraging relevant companies or institutions to participate in education informatization by contributing their own resources. Related to this is the aspect of taxation, where the government provides tax incentives to companies and individuals that participate in education informatization to make such participation more attractive. The statistical data show that these two areas also play a minor role (see Table 3).

3.1.3 DEMAND-SIDE POLICY INSTRUMENTS

Compared to supply-side and environment-related policy measures, demand-side measures play only a secondary role (see Table 2). Demand-side policy instruments include 11) public technology procurement, 12) external services, 13) trade controls, and 14) educational institutions abroad (see Table 3). Since very few documents deal with these types of measures, there has been a lot of variation over time here. Noteworthy among these are the topics of public procurement and trade controls.

In the selected documents, trade control is mainly concerned with the government's control over the supply of educational information technology in the market. For example, the 2002 *Information Technology Standards for Education Management* clearly states that education administrations at all levels are to conduct regular spot checks of software products developed by enterprises and used by schools, and publish the results of these checks. At the same time, relevant government agencies are to establish relevant evaluation and certification bodies to strictly control the man-

agement software introduced into the education system (see Ministry of Education of the People's Republic of China 2003a, p. 31). After entering the stage of education informatization 2.0, the state has issued a series of documents to comprehensively regulate the management and use of educational applications (apps). It focuses on the illegal and unlawful collection and use of personal information by online non-school educational institutions, online educational platforms and educational applications (apps), as well as the violation of consumers' rights and interests. It also strengthens the legal framework between education and the Internet and other related areas, and establishes a cross-sectoral and regular data security monitoring mechanism (see Ministry of Education of the People's Republic of China 2019b, p. 28; Ministry of Education of the People's Republic of China et al. 2019a; Ministry of Education of the People's Republic of China et al. 2019b, pp. 16–17; Ministry of Education of the People's Republic of China 2019c, pp. 3–4; Ministry of Education of the People's Republic of China et al. 2021b, p. 7).

Public procurement of technology means that the government purchases technical products on the market to strengthen technical support in the process of education informatization and to solve technical problems in the process. Thus, documents such as the *Notice on the Implementation of the School-to-School Connection Project in Primary and Secondary Schools* of 2000, the *Tenth Five-Year Plan for the Development of Education Informatization* of 2002, the *Draft of the National Medium and Long-Term Education Reform and Development Plan (2010–2020)* of 2010, the *Ten-Year Development Plan for Education Informatization (2011–2020)* of 2012, and the *Thirteenth Five-Year Plan for Education Informatization* of 2016, etc. clearly stipulated that the government was to fund the development and application promotion of leading resources, ensure the provision of public interest services by purchasing digital educational resources of basic quality, pay attention to the international market and vigorously introduce digital educational re-

sources of international quality, etc. (see Ministry of Education of the People's Republic of China 2000, p. 567, 2003b, p. 7, 2012a, p. 8, 2016, p. 56; Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2010, p. 13). It is worth noting that these measures are mainly focused on the 1.0 phase of education informatization. This is further evidence on phase 1.0 focusing on establishing facilities (see Section 3.2.1).

In addition, there are two other subcategories that are also briefly summarized here: External services refers to the government delegating some education informatization tasks to enterprises or other institutions to alleviate the pressure caused by the shortage of human resources and technology. Educational institutions abroad means that the government directly or indirectly establishes research and development institutions for education informatization abroad and enacts a management system with corresponding management measures.

3.2 ANALYSIS ON THE PROCESS AND RELATIONSHIP LEVEL

Having presented the content analysis, the research now focuses on the process and relationship levels from the perspective of the actors, the temporal context, and the different educational areas.

3.2.1 ACTORS IN EDUCATION INFORMATIZATION

In order to identify the key actors in the informatization of education in China, the documents were analyzed by editorship. Before that, however, it is necessary to give a brief overview of the political institutions in education informatization to enable the subsequent classification of actors on this basis.

Specification and systematization of political institutions

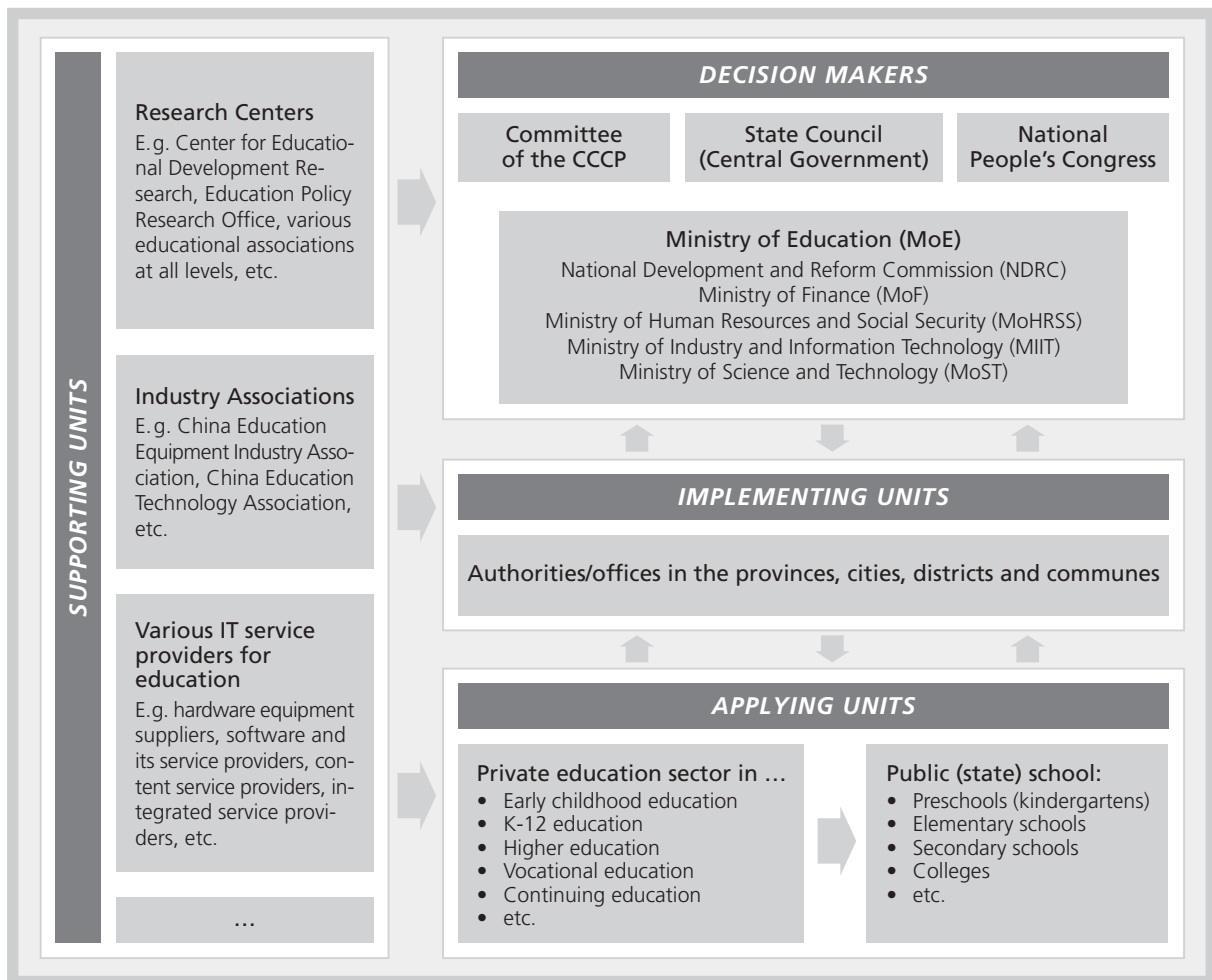
Education policy actors generally refer to individuals, groups or organizations that are di-

rectly or indirectly involved in the formulation, implementation, evaluation and monitoring of education policy. However, there are different views on the specific understanding of education policy actors. According to Yao's (2012) categorization of China's education system, there are four groups: Decision makers, supporting units, implementing units, and applying units (cf. Yao 2012, pp. 10–13, own translation)⁸. Based on the document analysis and supplementary sources, the actors and areas were assigned to the categories, taking into account the general state structures in China. These are summarized in their systemic context in Figure 2.

- The main decision-making body (决策主体) refers to the political party and the government, which hold a dominant position and the highest state authority (see Yao 2012, p. 10). In China, the Party Committee, the People's Congress, and the government are the main decision-making bodies in education policy. They are primarily concerned with the general and long-term interests of the country. Decision-makers in this sense means that they make the basic decisions that are then delegated to subsequent levels for programmatic elaboration, especially the various national

⁸ The article presents the results of a comprehensive research project of the Ministry of Education of China on "Research on the Reform of Balanced Development of Compulsory Education in China" (我国义务教育均衡发展改革研究10JZ00036) and the results of the key project of the Sichuan Provincial Department of Education "Institutional Improvement and Ecological Governance: Investigating the Implementation of Teacher Replacement Policies in Elementary and Secondary Schools" (制度完善与环境治理：中小学教师交流政策实施研究10SA032). In China, however, many scholars differ in their specific understanding of education policy actors. Yao summarizes the various classifications that have emerged and identifies four categories, taking into account philosophical and sociological definitions: Decision Makers, Supporting Entities, Executing Entities, and Application Entities. In this paper, Yao's classification is taken up because it is a cross-interest classification in which education policy is not only about "whose policy" is being made and "who is making it," but also "who is implementing that policy" and "who is the target of the policy" (Yao 2012, p. 10).

Figure 2: Political institutions and hierarchical structure in the informatization of education in China



Own illustration based on Yao 2012; iResearch 2019

ministries and provincial governments. These, too, are thus among the decision makers.

- Supporting entities (辅助决策主体) are organizations, institutes, companies, or individuals that collect, analyze, and process relevant information for decision makers and implementing agencies, conduct research and provide advice on specific issues, or provide support as specialized service providers (see Yao 2012, p. 11). From an educational science perspective, these include, for example, important bodies that support educational policy makers, national and local research centers for educational development, educational policy research offices, and educational associations at all levels (see Yao 2012, p. 11). The same applies to industry associations such as the China Education Equipment Industry

Association and the China Education Technology Association, which participate in and promote the informatization of education in China (see iResearch 2019, p. 7). In addition, various service providers for the informatization of education also play an important role, offering hardware, software, and services for the informatization of education (see iResearch 2019, p. 8).

- Implementing agencies (执行主体) are the units, organizations or individuals responsible for implementing education policies (see Yao 2012, p. 11). Thus, they are responsible for the implementation of education policy, which requires appropriate resources, means and methods. In this regard, implementing agencies include supporting forces in addition to the actors who provide the educational

activities. Therefore, education departments, human resources departments, schools and their local government personnel at all levels belong to the category of the main body for the implementation of education policy (see Yao 2012, p. 11).

- The area of application (对象主体) here refers to the places of learning, i.e., public (state) schools and educational institutions in the private education sector in China. Public (government) schools are the main object, and educational institutions outside the government system, i.e., in the private education sector, play a complementary role in promoting the informatization of the government education system (see iResearch 2019, p. 8). It should be emphasized that education and training institutions outside the state system are more open to new technologies and services due to their proximity to the market, so their level of informatization is relatively high and they play a leading role in the informatization of education (see iResearch 2019, p. 8). At the same time, they can contribute to a transfer of knowledge to public (state) schools through their experience and teaching content (see iResearch 2019, p. 8).

All actors are part of a mechanism of action that should ultimately enable the informatization of the educational system. As a systematic project, the informatization of education is defined and strategically promoted by decision makers on the national level. However, China is a large country both geographically and in terms of population, and the different development situations of each region in the national development process often limit the effectiveness of state policy implementation, as the content of relevant policy documents at the national level may not meet the actual needs of regional development. Against this background, regional governments, namely the above-mentioned implementing agencies, prepare documents on their own educational informatization within the framework of the national policy and ensure that the con-

tent of the policy is implemented in practice, i.e. in the field of application of education, in order to be able to promote the development of informatization in their regions in a targeted manner. For example, in April 2018, the Ministry of Education presented the *Action Plan for Education Informatization 2.0*. This was then followed by localized strategies from various provinces and cities, such as the *Education Informatization 2.0 Plan (2019–2022) in Shandong Province* in August 2019 and the *Education Informatization 2.0 Plan in Gansu Province* in January 2020. When individual provinces and municipalities achieve successful performance in practice, they will in turn be recognized by higher-level authorities as best practice examples, and their application in other municipalities will be specifically promoted. This mechanism is a combination of top-down control and dynamic bottom-up elements, and is a China-specific solution strategy to specifically address the wide disparity in the level of information technology development and the imbalance in the regional development of information technology.

Decision makers in the informatization of education

The documents selected for analysis are limited to those published by different actors on the national level. In the following, we will examine which actors act as authors and editors in this context, in order to analyze their role in the process of education informatization.

In terms of authors and editors, it should be noted that 28 of the 48 documents on the informatization of education originated from a single actor, namely only the Ministry of Education (MoE) and the General Office of the State Council. The Ministry of Education alone accounted for 25 documents, and the General Office of the State Council accounted for the remaining three. The remaining 20 documents were co-authored. Again, the Ministry of Education dominated with 15 documents, followed by the Ministry of Industry and Information Technology – MIIT (10), the Ministry of Finance of the People's Republic of

China – MoF (10), the National Development and Reform Commission – NDRC (9), the Central Committee of the Communist Party of China – CCCP (5), the State Council (6), the Cyberspace Administration of China – CAC (6), the Ministry of Human Resources and Social Security – MoHRSS (5), the Ministry of Public Security – MPS (4), the State Administration for Market Regulation – SAMR (4), the People's Bank of China – PBoC (3), and the Ministry of Science and Technology – MoST (2). Institutions with only one citation are omitted here.

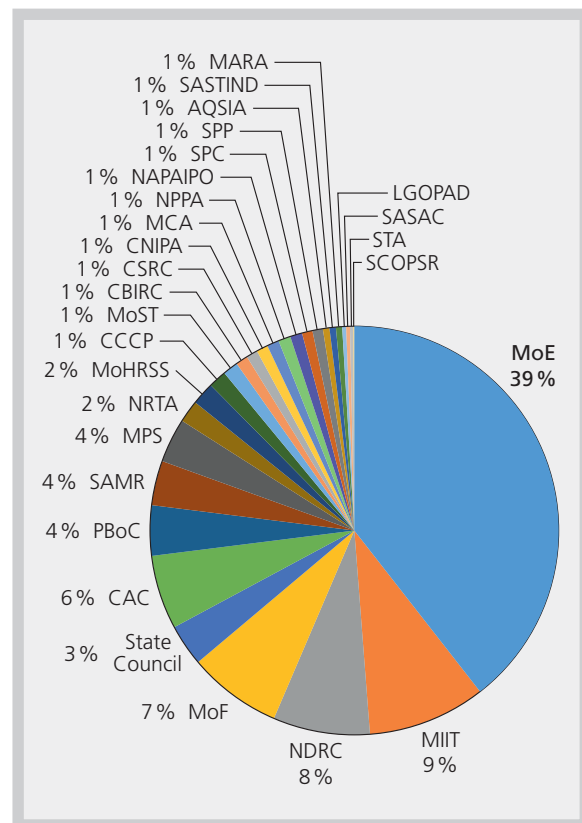
This results in a total of 28 participating institutions acting as authors. While in the first phase of education informatization (2001–2018) 14 institutions were involved in editing education policy documents, this number increased to 24 in the second phase (2018–2022). Such a change in numbers shows that the development of education policy also reflects a trend towards diversity or broad impact. It can also be seen as an increase in the importance of the issue as a whole. However, the Ministry of Education clearly dominates the field as author and co-author of 40 of the 48 documents. This shows that the Ministry of Education, as the author of trend-setting policy documents, plays the central role in shaping the informatization of education.

However, the analysis of the actors as authors is only a macro-perspective of the actors' participation in the process. In contrast, the analysis of the individual codes can be seen from a micro-perspective. Here it is possible to examine what proportion of the codes is accounted for by individual institutions. For the selected documents, the categorization of Rothwell and Zegveld (1981) into supply-, environment- and demand-based measures was used and coded (see Section 2.3). A total of 1567 codes were assigned. An analysis of the distribution of codes by author shows that the Ministry of Education is again the dominant actor with a share of almost 40%. At the same time, however, the topic is also taken up by a large number of other actors. These include MIIT (9%), NDRC (8%), MoF

(7%), CAC (6%), PBoC (4%), SAMR (4%), etc. (see Figure 3).

In summary, the Ministry of Education is the most important actor, both in terms of the total number of documents published and in terms of the coding of individual editors. At the same time, it is clear that a large number of actors are involved in the policy process and that cooperation in terms of jointly authored documents has increased significantly. It should also be noted that, in terms of content, the Ministry of Education's share of assigned codes is significantly lower than its dominance as a document author would suggest. This can be interpreted as an indication that the Ministry of Education's role in the overall subject matter is still limited. More actors are urgently needed to cover all aspects. If necessary, this can also be seen as an indication that there is a form of cooperative governance in the policy process that requires the participation of several actors.

Figure 3: Publisher of policy documents on the informatization of education in China



Own illustration

3.2.2 ADOPTION OF POLICY DOCUMENTS OVER TIME

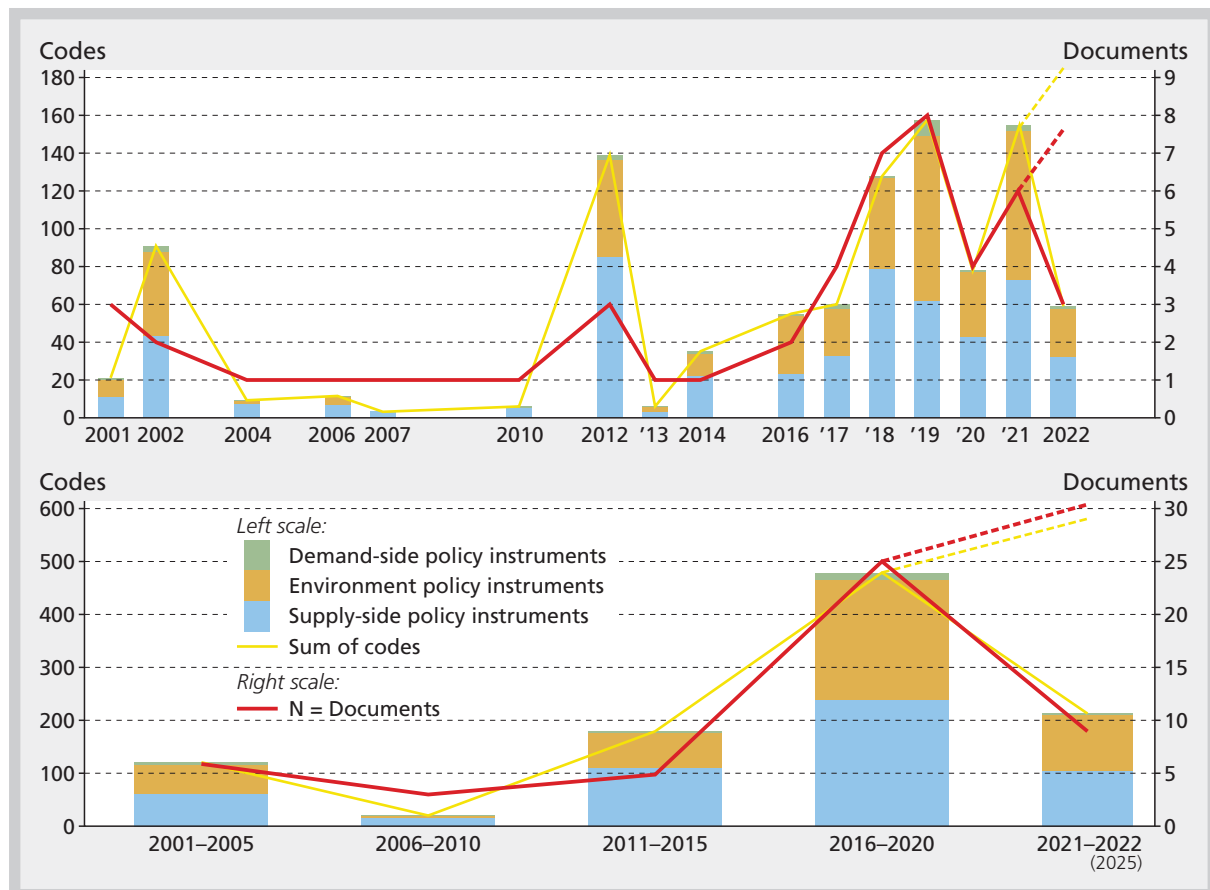
In the following, the distribution is examined in relation to the time of issue. This enables an assessment of developments and trends over time with regard to the topic. Analysis of trends over time also allows conclusions to be drawn about policy priorities.

Figure 4 shows the distribution of the selected documents and assigned codes over time, divided into two graphs. The upper graph gives an overview by years, while the lower graph is adapted to the rhythm of the five-year plans. The differently colored bars show the distribution of the codes in the three categories of Rothwell and Zegveld (1981). The trend in the total number of codes in each year is shown by the yellow line. The red line also shows the number of documents issued in each year. From the graph,

it is clear that most of the policies were adopted during the 13th Five-Year Plan (2016–2020). Both the total number of government documents and the total number of codes peaked in 2019. In addition, a significant increase can be seen from 2018, which represents the intensification of efforts on the *Education Informatization 2.0 Action Plan*.

Since the founding of the People's Republic of China, the Five-Year Plan has been an important tool for planning national economic activities. Therefore, the government's plan for the informatization of education at the highest level should be in line with the five-year plan. From the perspective of content analysis, each five-year plan actually has a focus related to education informatization. Therefore, the content of the selected documents is analyzed according to time. Thus, during the 10th (2001–2005) and 11th (2006–2010) Five-Year Plans, the state

Figure 4: Distribution by year of publication



Own illustration

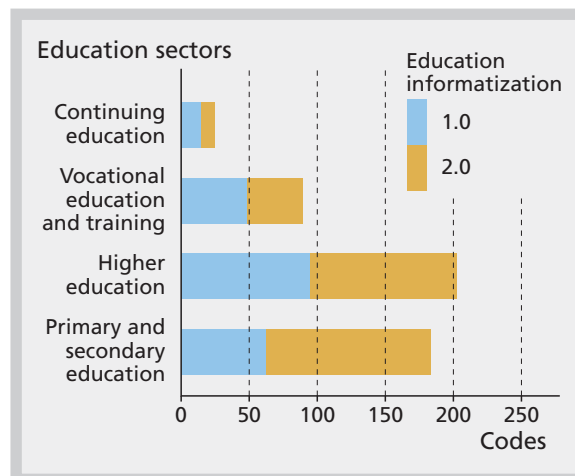
comprehensively promoted the “School-to-School Connection” project, carried out the construction of large-scale information technology infrastructure, and popularized information technology application services; during the 12th Five-Year Plan (2011–2015), China focused on the implementation of “Three Links and Two Platforms” to ensure the sharing of high-quality educational resources on a large scale; During the 13th Five-Year Plan (2016–2020), the country has continuously promoted the “Three Allrounders, Two Improvements, One Major” to develop a new education model for the information age (see Section 3.1 for more information). China is currently in the 14th Five-Year Plan (2021–2025), but the database so far is only available until March 2022, making the statistics for 2022 incomplete. Based on the past trend and the number of publications within just three months in 2022, it is expected that the number of documents will continue to increase during the 14th Five-Year Plan (see Figure 4). A summary of the policy documents of the 14th Five-Year Plan shows that with the completion of education management information systems and platforms at all levels and their initial entry into educational practice, the focus during this period was on educational equity, addressing data management issues, and promoting educational innovation (for more information, see Section 3.1).

From a macro perspective, it can be summarized that the informatization of education in China goes through the process cycle of “building infrastructure – developing software and resources – developing human resources – transforming teaching and learning” (Zhou et al. 2014, p. 13). This reflects both the internal logic of the development of informatization in education and the path of transforming learning and teaching through information technology.

3.2.3 DEVELOPMENT PRIORITIES IN THE EDUCATION SECTOR

This section will examine which educational areas are targeted by education policy and which priorities are set in this regard.

Figure 5: Development priorities in the education sector



Own illustration

In order to achieve this goal, the destination purpose was filtered for each educational sector, with the content/codes of primary and secondary education, higher education, vocational education and training and continuing education each grouped separately. Figure 5 shows the results for the distribution by educational sector. From this graph it can be seen that the focus of educational informatization so far has been on higher education, followed by primary and secondary education, then vocational education and training, with continuing education accounting for the smallest share. Comparing education informatization 2.0 with education informatization 1.0, only the share of primary and secondary education has been increasing again over time, while the other areas have been decreasing (see Figure 5). The key requirements for the use of informatization are very different in the respective educational sectors. A brief overview of each sector is given below.

Higher education

The *Ten-Year Development Plan for Education Informatization (2011–2020)*, released in early 2012, was the first national plan for education informatization in China. It explicitly refers to the detailed setting of development priorities for each education sector. In the field of higher education, the strategic positioning of informatization in higher education is characterized as “an

effective approach to promote the reform and innovation of higher education and improve the quality of education" and "the innovation front in the development of informatization of education" (Ministry of Education of the People's Republic of China 2012a, p. 5). The key tasks of informatization in higher education are then divided into four areas: 1) strengthening the construction and application of digital campuses in higher education institutions, 2) promoting the innovation of talent development, 3) promoting the level of scientific research in higher education institutions, and 4) strengthening the social service capacity and cultural heritage of higher education institutions (see Ministry of Education of the People's Republic of China 2012a, pp. 5–6). Finally, a framework for the development status of informatization in higher education is presented. This framework takes these four aspects as its starting point and measures the level of informatization at a higher education institution on the basis of 14 different dimensions (see Ministry of Education of the People's Republic of China 2012a, p. 6). The concept serves to convey the level of informatization of individual higher education institutions and thus contributes to transparency, comparability, and transferability. To promote the informatization of higher education, the state issued a series of documents in the following years, such as the *Thirteenth Five-Year Plan for Informatization of Education of 2016*, the *Action Plan for Innovation through Artificial Intelligence in Higher Education of 2018*, *Multiple Opinions on "Double First-Class" Construction of Colleges and Universities to Promote Discipline Integration and Accelerate Postgraduate Education in Artificial Intelligence of 2020*, and the *Specification for the Construction of Digital Campus in Higher Education Institutions of 2021*. These documents adjusted and clarified various aspects of the development tasks specified in the *Ten-Year Development Plan for Educational Informatization (2011–2020)*.

Primary and secondary education

In China, primary and secondary education is often referred to as "basic education" or "fundamental education" (Chinese: 基础教育). The *Ten-*

Year Development Plan for Education Informatization (2011–2020) positions the informatization of basic education as follows: "Informatization of basic education is the cornerstone for improving national information literacy and the top priority for informatization in education" (Ministry of Education of the People's Republic of China 2012a, p. 4). The main tasks of informatization in this area of education are then considered from three aspects: 1) bridging the digital divide and promoting the balanced development of compulsory education, 2) promoting the integration of information technology and teaching, and 3) developing students' learning skills in an information-based environment. As in higher education, a framework has been proposed for assessing the development status of informatization in basic education (see Ministry of Education of the People's Republic of China 2012a, pp. 4–5). This framework is divided into three aspects and nine dimensions, and has been refined in subsequent years through supplementary publications.

It is worth mentioning that students in this field of education are mainly pressured by the senior high school entrance examination (Chinese: 中考) and the national college entrance examination (Chinese: 高考), so the demand for efficiency and effectiveness in teaching and learning is very obvious. State documents typically reflect this by focusing particularly on supporting teaching and learning. For example, the *2008 Opinions of the Central Committee of the Chinese Communist Party and State Council on Comprehensively Deepening the Reform of Building Teacher Teams in the New Era* calls for "teachers to actively adapt to new technological changes such as information technology and artificial intelligence, and actively and effectively carry out education and teaching" (Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2018, p. 17). Subsequently, in 2019, the Ministry of Education's *Opinions on the Implementation of Project 2.0 to Improve the Application Capability of Information Technology for Elementary and Secondary School Teachers* emphasized the establish-

ment of a new information literacy development mechanism for teachers by 2022 that is school- and classroom-based, application-oriented, and innovation-focused (see Ministry of Education of the People's Republic of China 2019d, p. 60). In this way, the integration and innovative development of information technology and teaching are promoted in a comprehensive way. However, in promoting the integration of information technology and educational processes, it is also important to remember that this stage of education is focused on young people, so the use and application of information technology in education should be consistent with the cognitive development of students. At the same time, the protection of young people should be strengthened. With this in mind, the 2021 *Opinions of the State Council Leading Group on Youth Protection on Strengthening Youth Protection* identifies "improving the protection of young people on the Internet" as one of the most important tasks and presents a detailed plan (see State Council of the People's Republic of China 2021, pp. 30–31).

Vocational education and training

The *Ten-Year Development Plan for Education Informatization (2011–2020)* stipulates the informatization of vocational education and training (VET) as follows: "The informatization of VET is an important support for the training of high-quality workers and professionals, and is a weak link in education informatization that needs to be strengthened" (Ministry of Education of the People's Republic of China 2012a, p. 5). The main tasks of informatization in this field of education are then considered from three aspects: 1) speeding up the development of an informatized environment in VET, 2) effectively improving practical teaching in VET, 3) effectively supporting the training of highly qualified talents. As in the previous two education areas, a framework for the development status of informatization in VET was established (see Ministry of Education of the People's Republic of China 2012a, p. 5) and further elaborated in the following years. For example, the *Thirteenth Five-Year Plan for the Informatization of Education* published in 2016 states

that a special pilot project on digital resources for VET will be carried out, a national model program for the exchange of digital resources in vocational schools will be implemented, the development of a "professional library of teaching materials for VET" will be continued, and the widespread use of this library in vocational education institutions will be promoted (see Ministry of Education of the People's Republic of China 2016, p. 55). The *Guiding Opinions of the Ministry of Education on Further Promoting the Development of Informatization of Vocational Education in 2017* comprehensively implement six key tasks to promote the informatization of VET: Improve the basic capacity of vocational education informatization, promote the sharing of high-quality digital education resources, deepen the innovation of education and teaching models, accelerate the construction and application of management service platforms, improve the information literacy of teachers, students and administrators, and improve the control of network and information security (see Ministry of Education of the People's Republic of China 2017). The *2020 Action Plan for Improving the Quality of Vocational Education (2020–2023)* also recommends the implementation of informatization in VET, which can be summarized in four tasks: 1) Implement the Digital Campus Specification for Vocational Education Institutions document, develop guidelines for the construction of school computer centers, and guide vocational schools to systematically develop comprehensive solutions for school informatization. 2) Establish and improve certification standards and transaction mechanisms for shared resources, and promote the construction and application of professional teaching resource libraries on the national, provincial and school levels. 3) Select about 300 benchmark schools for vocational education informatization and about 100 model virtual training bases. 4) Select about 5,000 high-quality open online vocational education courses for public basic courses and vocational (qualification) courses (see Ministry of Education of the People's Republic of China et al. 2020b, p. 48).

In summary, the government's policy focuses on information technology infrastructure, teacher training, the development of resources for the digital environment, and practical projects in the field of education informatization in vocational training institutions.

Continuing education

The *Ten-Year Development Plan for the Informatization of Education (2011–2020)* stipulates the informatization of continuing education as follows: "The informatization of continuing education is an important support for the construction of a lifelong learning system" (Ministry of Education of the People's Republic of China 2012a, p. 6). The major tasks of informatization in this field of education are then considered from three aspects: 1) promoting the construction and sharing of digital resources for continuing education, 2) accelerating the construction of a public service system for lifelong learning through information technology, 3) strengthening the construction of a public information management and service platform for continuing education. To this end, a framework for the development status of the informatization of continuing education was also established (see Ministry of Education of the People's Republic of China 2012a, pp. 6–7) and then specified in more detail.

In the selected documents, there are several references to the proposal to build an educa-

tion system that enables lifelong learning for all through education informatization. For example, the *Thirteenth Five-Year Plan for Education Informatization* in 2016 proposed that the e-action plan for continuing education in higher education should be vigorously implemented for various industries and enterprises, and that open universities, senior universities, and vocational education should be strengthened to promote lifelong learning for all (see Ministry of Education of the People's Republic of China 2016, p. 56). In addition, continuing education should adopt a hybrid teaching model that combines online and offline learning, thereby combining convenient, flexible, and personalized learning conditions for all with the goal of lifelong learning (see Ministry of Education of the People's Republic of China 2016, p. 57). The document *China's Modernization of Education 2035*, published in 2019, also proposes to build an education system that enables lifelong learning for all through the computerization of education (see Central Committee of the Chinese Communist Party and State Council of the People's Republic of China 2019a, p. 10). In addition, the document mentions several times that continuing education should focus on distance education for special groups (such as migrant workers, people with disabilities, veterans, etc.) and that information technology should be used to promote the development of public education services.

4 DISCUSSION

Based on the above findings, this section summarizes, classifies and interprets the characteristics, basic logic and intentions of China's informatization education policy.

Growing importance of the topic of education informatization

Of the 48 documents included in this study, 25 belong to the education informatization 1.0 phase (2001–2018) and 23 to the education in-

formatization 2.0 phase (since April 2018) (see Table 1). This results in an almost equal distribution of the number of documents between the two phases, although these phases are of very different lengths. This can also be seen as a clear indication of the increasing importance of the topic. The evaluation of the years of publication and the distribution of the codes also shows an overall increasing trend over time, which reinforces this statement.

Comprehensive national policy on the development of education informatization

It was possible to identify different political instruments that play different roles in national politics. Overall, a political system with different mechanisms of action emerges:

- The supply-side policy instruments provide direct support to the concerned actors in the form of driving forces (push effects). Educational measures (1) and Scientific and technical approaches (2) establish a system of government control in the areas of education, information systems, technology and science. The Finance measure (3) provides direct financial resources from the national level. Public services (4) focuses on various support services provided by the government to ensure the normal and proper progress of educational informatization.
- The environment-related policy instruments play an indirect role by providing a favorable environment for the development of educational informatization. Measures such as Policy planning (5) and Legal and regulatory requirements (8) are to ensure an orderly process on the administrative level. At the same time, however, they focus on conformity aspects to set up and ensure legitimate, standardized and legal procedures for the development of educational informatization. Measures such as International exchange and cooperation (9) and Promoting equal opportunities in education (10) aim to create an open and equitable environment for the development of educational informatization. In addition, there are two other subcategories, i.e. Financial support (6) and Taxes (7). These are about government encouragement and/or tax incentives for relevant companies or institutions to participate in education informatization by contributing their own resources.
- The demand-based policy instruments provide direct support to the relevant subjects in

the form of pull effects, mainly based on the demands of the various subjects in reality. Measures such as Public technology procurement (11), External services (12) and Trade controls (13) are designed to facilitate the functioning of the internal market. The measure Educational institutions abroad (14) is only intended to promote foreign markets.

Based on the quantitative analysis conducted, it is clear that the Chinese government's policy priorities are focused on supply-side and environmental education measures. Demand-side measures play only a minor role (see Table 2). The content analysis illustrates the various aspects of the Chinese government's education informatization policies, such as education management (policies corresponding to subcategory 1), technical knowledge (policies corresponding to subcategory 2), market information (policies corresponding to subcategories 4, 8, 9, 10), financial resources (policies corresponding to subcategories 3, 6, 7), domestic education markets (policies corresponding to subcategories 11, 12), and international education markets (policies corresponding to subcategories 13, 14). These various policies have directly contributed to the strengthening of education informatization R&D in China.

The change in political priorities over time as an incremental transformation process

By analyzing time periods corresponding to the education informatization 1.0 and 2.0 phases and comparing the results, it is evident that since the start of the education informatization 2.0 phase there has been a decline in supply-oriented government policies. At the same time, there has been an expansion of activities and a greater focus on environmental policy instruments (see Table 2). This is mainly due to a shift in priorities from the scientific and technical approach to the legal and regulatory approach (see Table 3). It seems plausible that this adjustment of priorities is also due to changing needs in an ongoing development process.

At the same time, the priorities in terms of content are strongly dominated by the respective five-year plan, although here, too, an incriminating transformation process can be seen in the way in which the respective development priorities are interlinked and build on one another. Overall, different stages of development are discernible, suggesting that China's educational informatization follows the process schema of "building infrastructure – developing software & resources – developing human resources – transforming teaching and learning" (Zhou et al. 2014, p. 13). This reflects both the internal logic of the development of information technology in education and the path of transforming learning and teaching with the help of information technology.

Focus on higher education and primary and secondary education

In the further course of the paper, it was explained how educational policy is distributed and where priorities are set (see Section 3.2.3). It was shown that the focus of educational informatization has so far been on higher education, followed by primary and secondary education, and then vocational education and training. Continuing education has so far had the smallest share. If we compare the phases of education informatization here, since 2019 there has been a shift towards primary and secondary education, while the other areas have declined. This development can also be explained by the effects of the COVID-19 pandemic.

In primary and secondary education, the focus is on supporting teaching and learning. This reflects the emphasis on efficiency and effectiveness in these education sectors, which are heavily influenced by entrance and final examinations. In vocational education and training, on the other hand, government policy focuses on information technology infrastructure, teacher

training, the development of resources for the digital environment, and practical projects in the area of informatization in vocational education institutions. In the case of continuing education, the focus is particularly on the possibilities of educational informatization for lifelong learning. In addition, and related to this, the aspect of participation and inclusion is emphasized, using information technology to provide targeted distance learning for special groups (e.g. migrant workers, people with disabilities, veterans) and to promote the development of public education services.

Coordination processes and structures in place among stakeholders

As part of the analysis, the documents were examined according to their author and the codes assigned according to their origin, in order to identify the actors involved. In addition, a frequency analysis was conducted to draw conclusions about their role. The Ministry of Education was identified as by far the most important decision maker at the national level. This applies to both the number of documents and the amount of coding. At the same time, a large number of other actors involved in the process were identified, such as the State Council as well as MIIT, NDRC and MoF. The diversity of actors increases over time, which can be seen as a sign of coordination processes and evolving structures. It should also be noted that from a content perspective, the Ministry of Education's share of assigned codes is significantly lower than its dominance as a document author would suggest. This can be interpreted to mean that the Ministry of Education's share in the overall subject matter is nevertheless limited. Other actors are needed in the process to cover all aspects. Perhaps this can also be seen as an indication that the policy process involves a form of cooperative governance that requires the participation of multiple actors.

5 CONCLUSION AND OUTLOOK

The study examined Chinese education policy in the context of digital transformation. It was based on a computer-assisted, qualitative document analysis of national government documents from 2001 to 2022. This period covers the phases of the so-called education informatization 1.0 and 2.0 in China – from the early days of networked home computers to today's intelligent, personalized and interactive applications on mobile devices.

Following a two-dimensional analytical framework, this paper comprehensively categorized government policies on the informatization of China's education system, thereby revealing the China-specific education policy strategy. Following Rothwell and Zegveld's (1981) approach, policy documents were coded and analyzed into three categories with 14 subcategories. The results were analyzed in terms of both content and temporal context. The main findings can be summarized as follows (see Chapter 4): The issue of informatization of education is gaining importance throughout China. National policies have been promulgated in various areas and have set clear priorities for implementation. These policy priorities, combined with the country's development needs, are driving the transformation of teaching and learning. The focus of transformation is primarily on higher education and primary and secondary education. There is also an increasing diversity of policy makers, involving many departments in addition to the Ministry of Education.

Based on a systematic analysis of documents, the paper deals in depth with the design of the educational policy strategy for the informatization of education in China. Nonetheless, this work has limitations that should be taken into account when drawing possible conclusions.

- Language, terminology and meanings: Different terms and meanings in different languages

make international, common understanding difficult. For example, Chinese terms such as educational informatization, decision makers, support instances, etc. may be understood and used differently in English or other languages. This leads to significant problems in translation, explanation of the term, and definition of appropriate indicators for data collection.

- Another limitation of this study is that the analysis of documents was carried out only on the national level; regional policies were not taken into account. At the same time, a complete survey of all policy documents in the period was not conducted. Out of 120 documents, 48 were classified as issue-related and thus potentially relevant and were used for further analysis. The selection of other documents could also provide other characteristics in detail.

In the course of the work and following the results, further questions have arisen that present starting points for future research. This need for further research is outlined below.

The focus of the work has been on outlining an overall strategy. However, there is a need for further research on specific aspects, such as the individual education sectors and their specific challenges, or the actors and how they interact and cooperate in the process. In this respect, each individual aspect offers room for further research.

- For this study, the policy documents were coded and analyzed according to the method of Rothwell and Zegveld (1981). The choice of a different model will presumably also lead to a different result.
- The strategy for China that is presented here can be used as a basis for a comparison with the strategy of any other country.

- This work provides a deeper understanding of the policy processes and strategy of education informatization in China. In this way, it can provide support and guidance to educational institutions and policy makers in designing and comparing educational strategies.

This paper summarizes the results of the first phase of the ChiKUBIG project funded by the German Federal Ministry of Education and Research (BMBF). Further studies will follow.

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APPENDIX: LITERATURE LIST OF THE SAMPLE ANALYSIS

To get insight into the current state of research, a sample study of the 20 most cited scientific articles from the 125 scientific publications on the keyword “education informatization, policy” (教育信息化政策) in the CNKI database was con-

ducted (as of Dec. 2022). The literature list for the sample analysis is shown in Table 4. These 20 papers are listed in decreasing order according to the number of citations.

Table 4: Literature list of the sample analysis

Article Title	Author Full Names	Source Title	Year	Quoted from
Research on Macro Policies and Strategies of Educational Informatization 教育信息化的宏观政策与战略研究	Jiao Jianli, Jia Yimin, Ren Gaimei 焦建利,贾义敏,任改梅	Journal of Distance Education 远程教育杂志	2014	187
A Policy Comparison, Development Tendency and Enlightenment of Education Informatization Evaluation 国内外教育信息化评价的政策比较、发展趋势与启示	Zhang Chenjingzi, Wang Ying, Wang Xiaodong, Jiao Jianli, Zhang Yinghua 张晨婧仔,王瑛,汪晓东,焦建利,张英华	Journal of Distance Education 远程教育杂志	2015	73
A New Trend of Teaching and Learning Reform Supported by ICT: From “Technology-orientation” to “Learning-orientation” 从“技术导向”到“学习导向”——信息技术支持的学与教变革国际发展新动向	Zhou Xiaoqing, Wang Xiaodong, Liu Xian, Li Qiong, Jiao Jianli 周晓清,汪晓东,刘鲜,李琼,焦建利	Journal of Distance Education 远程教育杂志	2014	59
A review of the development of China’s educational information technology 我国教育信息化发展历程回眸	Zhong Zhixian, Zhang Qi 钟志贤,张琦	The Chinese Journal of ICT in Education 中国教育信息化	2007	58
A Forward Path and Enlightenment of Policies of ICT in Education in Developed Countries 发达国家教育信息化政策的推进路径及启示	Wu Di, Yu Liqin, Li Congcong, Yu Xiaorong 吴砥,余丽芹,李枳枳,尉小荣	E-education Research 电化教育研究	2017	57
Analysis of the Educational Informatization Policies in Japan and Significances for China 日本教育信息化政策分析及其对中国的启示	Zhang Wie, Li Zhe, Okubayashi Taichiro, Jia Ruo 张玮,李哲,奥林泰一郎,贾若	Modern Educational Technology 现代教育技术	2017	56
The International Development Trend on ICT in Education (2015–2016) 2015年度国际教育信息化发展动态及趋势分析	Wei Xuefeng, Li Fengqing, Zhong Qianru 魏雪峰,李逢庆,钟靓茹	China Educational Technology 中国电化教育	2016	55
Research on the Development and Countermeasures of National Education Informatization Policy 国家教育信息化政策的发展及对策研究	Zhang Qianwei 张倩苇	China Educational Technology 中国电化教育	2005	53
Research on International ICTs in Education Development: Content and Conclusions 国际教育信息化发展报告:内容与结论	Zhang Jinbao, Huang Ronghuai, Wu Di 张进宝,黄荣怀,吴砥	Open Education Research 开放教育研究	2014	49
Study on Leadership in the Education Informatization Management Practice 教育信息化管理实践中的领导力研究	Wang Ying, Jia Yimin, Zhang Chenjingzi, Wang Wenhui, Jiao Jianli 王瑛,贾义敏,张晨婧仔,王文惠,焦建利	Journal of Distance Education 远程教育杂志	2014	39

Article Title	Author Full Names	Source Title	Year	Quoted from
Research on the Informatization Policy of Basic Education in South Korea 韩国基础教育信息化政策研究	Cui Yingyu, Sun Qilin, Tao Ying 崔英玉,孙启林,陶莹	China Educational Technology 中国电化教育	2011	34
A study of the development of educational technology in foreign language education in China's universities 我国高校外语教育信息化政策发展研究	Wang Jing 王静	Shanghai International Studies University 上海外国语大学	2017	34
The Development and Enlightenment of Educational Informatization Policy in Developed Countries 发达国家教育信息化政策的发展及其启示	Song Li 宋莉	Journal of Inner Mongolia Normal University 内蒙古师范大学学报(教育科学版)	2007	32
Research on Mechanism of Public Service Supply of Digital Educational Resources: Based on Studies on Policy Changes of ICT in Education from 1996 to 2018 数字教育资源公共服务供给机制研究——基于1996–2018年教育信息化政策变迁的研究	Gao Tiegang, Zhang Dongrui, Geng Kefei 高铁刚,张冬蕊,耿克飞	E-education Research 电化教育研究	2019	32
A Study on the Evolution of the Policy of ICT in Education in China (1989–2016) 我国教育信息化政策演进(1989–2016年)研究	Zhong Zhixian, Zeng Rui, Zhang Xiaomei 钟志贤,曾睿,张晓梅	E-education Research 电化教育研究	2017	29
Characteristics and Prospects of Educational Informatization Policy in China in Four Decades Since Reform and Opening Up 改革开放四十年我国教育信息化政策特征与展望	Zhang Guoqiang, Xue Yixin 张国强,薛一馨	E-education Research 电化教育研究	2018	28
Analysis and Countermeasures of Educational Informatization Policy Implementation Deviation 教育信息化政策执行偏差分析与对策研究	Hu Xiaoyong 胡小勇	China Educational Technology 中国电化教育	2011	25
The Evolution and Characteristics of China's Teacher Education Informatization Policy 中国教师教育信息化政策的演进与特点	Du Yuxia 杜玉霞	E-education Research 电化教育研究	2013	23
The Construction and Analysis of the Chronology of my country's Education Informatization Policies and Regulations 我国教育信息化政策法规年表构建与分析	Zhao Huichen, Ma Huanhuan 赵慧臣,马欢欢	Modern Distance Education Research 现代远程教育研究	2012	23
A Study of ICT Policies in the Basic Education of China 对我国基础教育信息化政策的梳理与思考	Liu Yaoyue 刘垚玥	Theory and Practice of Education 教育理论与实践	2016	22

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