

# Design of Digital Framework for Regional Education Supervision based on Cloud Computing

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## Abstract:

With the rapid development of cloud computing and other emerging information technologies, the pace of informatization in the education industry is also accelerating. The modernization and digitalization of educational supervision are also facing new opportunities and challenges. Based on the analysis of the current digital deficiencies in the implementation of educational supervision and the advantages of cloud computing, this paper proposes a hierarchical framework for the digitalization of educational supervision, and elaborates on the hierarchical functions and characteristics of the framework in order to serve as educational supervision. Provide reference for digitalization and modernization.

**Keywords:** Cloud computing, Regional Education Supervision, Digital framework.

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## I. INTRODUCTION

In the *Outline of the National Medium-and Long-term Education Reform and Development Plan (2011-2020)*, emphasis is placed on "promoting the informatization of government education management, accumulating basic information, mastering the overall situation, strengthening dynamic monitoring, improving management efficiency. Integrating various education management resources at all levels, building a national public service platform for education management, providing scientific basis for macro-decision-making, providing public education information for the public, and continuously improving the modernization level of education management" [1]. As education supervision is an important part of education management, the modernization of education supervision is an indispensable part of the modernization of education management.

Digitalization is an important feature of the modernization of educational supervision, and data is an important content and representation of digitalization, which provides a basis for various business decisions of educational supervision. Yang Zongkai believed that the complete infrastructure and

abundant online data in China provide data support for the modernization of education supervision [2]. However, at the beginning of the construction of these databases, they were not uniformly planned and designed as a whole, and were constructed separately by different business offices or even special work, without correlation with each other [3], which is a challenge to further promote the digital construction of educational supervision. As a result, some scholars try to introduce emerging technologies to deal with this situation. Most of these studies only start from the perspective of big data, laying a foundation for the modernization of education supervision [4].

As a new technology, cloud computing can be positioned as a new data service mode in essence. Although the application scope of cloud computing is expanding day by day in recent years, there are few researches on digital education supervision based on cloud computing technology. Cloud computing is an optimal scheduling service based on the existing digital resources, which can flexibly and efficiently solve the problems of data sharing, thus cracking the data barriers [5]. Therefore, in this paper, we intend to build a digital framework of regional education supervision from the perspective of cloud computing, and try to provide a brand-new solution for the modernization of education supervision.

## **II. CHALLENGES FACED BY DIGITALIZATION OF EDUCATIONAL SUPERVISION**

### **2.1 The Limitations of the Current Educational Supervision Data Flow Mechanism**

#### **2.1.1 Limited access to monitoring data at all levels**

At present, there are two main ways to obtain educational supervision data, namely, data collection and field investigation, in which "data collection" is specifically carried out according to the following procedures: supervised objects at all levels guided by standards of supervision evaluation, fill in relevant work progress and generate self-inspection reports, and send the self-inspection reports to the higher-level steering committee within a limited time, while "field investigation" is carried out by grouping supervision experts based on the data of "data collection" according to the different situations presented in the self-inspection reports of various places, and then selecting some schools from each group to carry out "random class supervision" and "on-the-spot inspection" to investigate the actual situation of education and teaching and obtain first-hand data. Obviously, the acquisition methods and their limitations of educational supervision data are interdependent and mutually bound in such a completely manual supervision mode. Moreover, due to the limitation of manpower, only a small number of schools and some education administrative departments can be selected as samples for supervision and evaluation, resulting in a small data size and time consumption but difficulty in getting comprehensive, accurate and objective results.

### 2.1.2 Backward means of supervision data evaluation and analysis

Data collection is the basis of supervision, and data analysis and evaluation is an essential part of supervision. At present, the supervision data of most regions are still mainly analyzed manually, mainly relying on the subjective analysis of experts' knowledge and experience, which obviously lags behind the current digital way of data monitoring and evaluation in the information age and has low efficiency. Such as, the results of education supervision and evaluation often cannot reflect the real problems existing in education, teaching and education governance in a timely, objective and scientific manner[6]. Besides, due to the lack of scientific, timely and effective data support, the credibility and persuasiveness of the problems of education teaching and education governance presented by subjective analysis-based data analysis methods are weakened to some extent, which ultimately affects the formulation of education policies and the improvement of education governance ability.

### 2.1.3 Difficulty in updating and maintenance of supervision data at the primary level

Due to the lack of information-based storage management of data at the primary level, the updating and maintenance of data can hardly be carried out by advanced data processing methods. At the same time, no vertical correlation is formed between the data at the primary level and higher level, which makes it very difficult to update the data at the primary level and improve the efficiency due to the large amount of repetitive work. Once the indicators of regional supervision and inspection change, the data at the primary level will be collected from the very beginning, which virtually increases the work pressure and lowers the work efficiency. In addition, the difficulty in updating and maintaining the data and the data gaps at all levels are not conducive to the generation of a long-term mechanism to supervise the data.

## 2.2 Deficiency of current educational supervision data environment

### 2.2.1 Lagging concept of data application

The concept of supervision data application has an important influence on supervision modernization. At present, education supervision is mostly conducted manually, and there is a lack of scientific data concept in data acquisition, evaluation and analysis. On the one hand, because most of the supervisory staff are part-time staff, even the full-time supervisory staff have low scientific and quantitative data processing capability. On the other hand, the old concept of supervision for many years is difficult to change and slow to change.

### 2.2.2 Lack of systematic data infrastructure planning

At present, although special supervision databases have been established in a few regions, the lack of systematic planning and design is a common problem in the construction of these databases. The construction of the database is promoted by different business offices or different special work, but there is no necessary communication between them. Even, the data standards of each database are not uniform, and the evaluation indicators are entered in different databases respectively. In this way, it is easy for data to be inconsistent or even contradictory, and finally cannot be shared. Therefore, with the prominent problems of Information Island and low data quality, it is difficult to meet the application needs of the follow-up regional supervision data comprehensive analysis.

### 2.2.3 Limited scope of supervisory statistics

At present, not only the scope of supervision statistics is narrow, but also the existing data resources only remain in the category of resource data, such as the allocation of human, financial and material resources. The scope of data collection is naturally narrow due to mainly manual supervised data collection and processing and limited statistical data ability [7]. Besides resource data, other types of data are also very important in educational supervision. For example, the data reflecting the area, the quality of school education and teaching, the development of school connotation, etc., directly affect the function of evaluation and monitoring; the data reflecting social public opinion directly affects the judgment of government departments on public evaluation of educational policies and measures. However, due to the limited means of data collection and processing, these important data types can only be temporarily put back.

## **III. CURRENT SITUATION AND ADVANTAGES OF CLOUD COMPUTING ENVIRONMENT IN CHINA**

### 3.1 Current Situation of Domestic Cloud Computing Environment Construction

China has continuously increased its investment in promoting the construction of education cloud. In the Ten-year Development Plan for Education Informatization (2011-2020) released by the Ministry of Education in March 2012, it is clearly proposed to build a national education cloud infrastructure platform, which requires that the information infrastructure of various educational institutions at all levels should be fully integrated and utilized to build a nationwide, reasonably distributed and open source basic cloud environment to support the formation of a hierarchical structure of cloud infrastructure platform, cloud resource platform and cloud education management platform (Ministry of Education, 2012).

Since 2011, China has started various educational cloud construction and pilot work at the national and local levels. The national education resources public service platform, namely the National Education Cloud, was launched in December 2012. Many colleges and universities have also established education and teaching management platform based on educational cloud [8].

Thus, it is obvious that the construction of cloud computing environment is being vigorously carried out in China, and its application is constantly being promoted in the education and teaching environment. Therefore, it is feasible for educational supervision to promote the reform of digital construction in the cloud environment.

### 3.2 Advantages of Cloud Computing Environment Application

#### 3.2.1 Advantage I: Scheduling on demand

With the rapid development of information technology, the requirements of education management service on the use of data have changed: from the pursuit of large capacity data storage to ubiquitous flexible scheduling on demand. Under the support of cloud computing technology, the underlying implementation details of the information network are hidden by the core virtualization technology, and then the data function is stripped from the data entity at the management level, and finally the information service system facing the data users is reconstructed, which is the key to realize "on-demand" scheduling of data in the cloud computing environment [9]. Thus, once the regional supervision digital system based on cloud computing technology is successfully built, it can support different data use requirements of all levels of supervision, and is characterized by convenience, flexibility and quick response.

#### 3.2.2 Advantage II: Changing "static" to "dynamic"

On the whole, the regional digital framework based on cloud computing can optimize data sources, improve data application modes and enhance data exchange and sharing among schools and functional organizations in the region according to the corresponding regional characteristics, which can enjoy better services at lower cost and improve supervision efficiency. From a local perspective, in the cloud computing environment, more attention is paid to the standardization of data standards and the targeting of data services, which can promote the barrier-free circulation and interoperability of education supervision services in the region, change the construction of data from static database to dynamic "streaming" platform construction, and greatly improve the output value of supervision services.

## **IV. DESIGN OF REGIONAL EDUCATION SUPERVISION DIGITAL FRAMEWORK BASED ON CLOUD COMPUTING**

### **4.1 Principles of Digital Framework Design for Educational Supervision in Cloud Environment**

#### **4.1.1 Paying attention to regional characteristics**

Unbalanced development of regional digitalization, disunity of data construction standards, serious problems of data impoverishment and homogenization, and uneven fault tolerance of software and hardware of data services, etc., have become obstacles that must be overcome in the process in digitalization of educational supervision. Therefore, in the design of digital framework based on cloud computing, it is particularly necessary to take the regional characteristics as the basis, make full use of the advantages of cloud computing, comprehensively consider factors such as regional digital ecology and digital input cost, focus on differences in data requirements of all levels and all types of supervisors, and consider business integration and docking relations in different regions, so as to truly pay attention to regional characteristics and expected application prospects.

#### **4.1.2 Facilitating flexibly position**

Because the educational supervision data in the region is oriented to multiple users such as grassroots data providers, educational supervision and management functional departments, etc., and involves different levels of functional requirements, it is characterized by diversification, dynamics and hierarchy. Therefore, in the design of the framework, it is necessary to describe a variety of cooperative and interdependent relationships from a macro perspective, so as to realize the flexible positioning of different users' differentiated data requirements, and to integrate the aggregation, configuration and scheduling of information into the business chain of cloud services, so as to achieve the ecological unity of the macro-layout and micro-control of supervision data construction.

#### **4.1.3 Sustainable development**

The work content of educational supervision always keeps pace with the times, so the supervision data should be dynamic and constantly updated alternately. In view of this, it is necessary to adhere to the principle of sustainable development in the construction of digital framework of education supervision in the region, not only to support the existing data scheme, but also to have good compatibility with new data indicators and norms. The solution and architecture must also be scalable when implementing the regional education supervision data integration assessment. When new schemes or indicators and specifications need to be deployed or replaced, the original framework can be prevented from being modified at the bottom or reconstructed subversively, so that the system can have



certain scalability and integration, thus realizing real sustainable development and reducing unnecessary waste of resources.

4.2 The Overall Design of the Digital Framework for Regional Education Supervision

Based on the above analysis, a prototype of the digital framework for regional education supervision is proposed in this paper, as shown in Fig. 1 below, whose main body is implemented in a hierarchical structure, which minimizes the complexity of the data deployment and development process [10]. Hierarchical structure refers to a kind of automatic test code structure, which is the most popular and widely used application software design method at present. The hierarchical framework of education supervision based on cloud computing consists of five layers, from bottom to top: supervision data foundation layer, cloud computing infrastructure service layer, supervision data cloud service supply layer, supervision data application layer and cloud layer. Low layers serve high layers, and the data services between the upper and lower layers can circulate with each other. Because the security performance of the system is a very important index in today's digital system, it is very necessary to provide security authentication, trust management, data encryption and other services for users at all levels of the system in order to ensure the security of the digital system. Therefore, in the framework of the system, systematic security rules are specially set: data service and security standards of regional education supervision, which run through all levels and protect the system security.

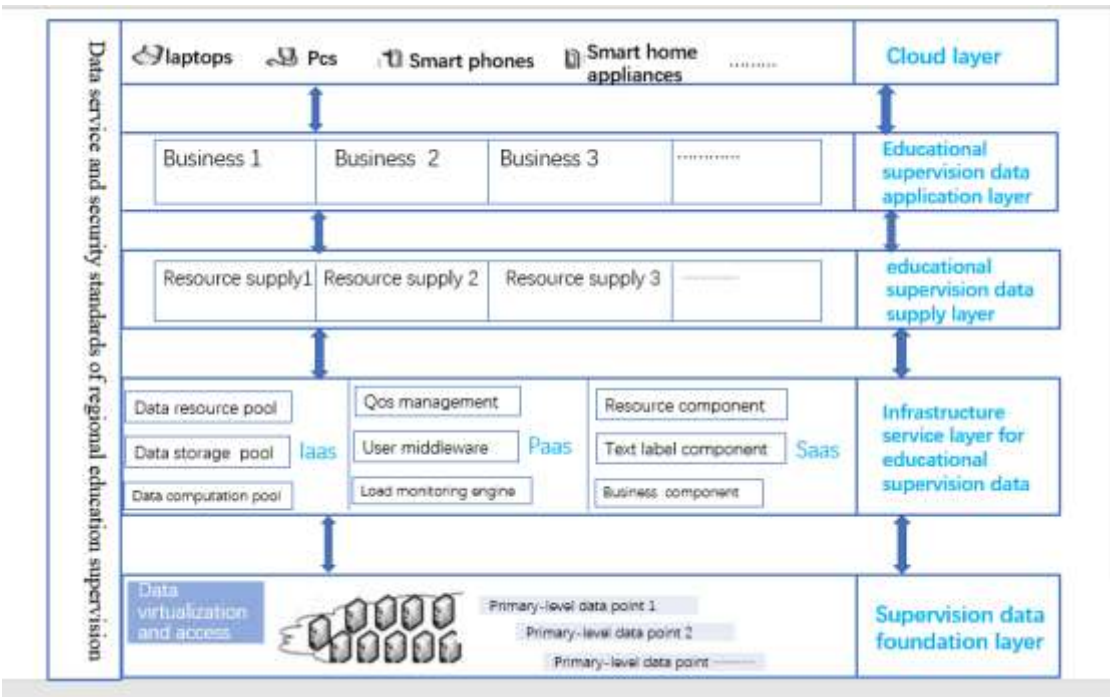


Fig 1: The digital framework for regional education supervision

Based on the hierarchical design characteristics of the framework, when developers face different demands of educational supervision data in different regions during the actual development of the system, they only need to give priority to the functional construction of a certain layer or layers according to the actual demands of a certain region. In this way, the prototype design of regional digital framework can be easily and flexibly promoted across regions at low cost[11]. Furthermore, the hierarchical design feature based on the framework enables people to focus more on how to "use" the advantages of the education cloud, produce more optimized, visualized and intelligent education supervision data, and generate greater social benefits.

#### 4.3 The Hierarchical Function of the Digital Framework of Regional Education Supervision

##### 4.3.1 Supervision data foundation layer

Looking at the digital framework of education supervision from the bottom to up, the educational supervision data foundation layer is located at the bottom level, which is the backbone of the high-level level in the framework. With the help of cloud terminal technology, it virtualizes and encapsulates various software and hardware resources such as data packets, servers, databases, storage devices, etc. in the regional network space into virtual data resources with different granularity, and encapsulates these virtual resources into special cloud services through cloud service tools.

With the support of the access interface, the supervision data foundation layer centrally manages and operates cloud services according to the operation mode of cloud computing, provides reliable data support for the infrastructure service layer of cloud computing, facilitates the data co-construction and sharing business among different organizations in the region, and promotes the improvement of the business efficiency of regional education supervision.

##### 4.3.2 Cloud computing infrastructure service layer

Looking at the digital framework of education supervision from the bottom to up, the level above the bottom (educational supervision data foundation layer) is cloud computing infrastructure service layer, which deploys the virtualized data encapsulated and accessed by the basic layer of supervision data in the cloud nodes, and establishes the data service indicator to realize the "pooling" and dynamic scheduling of supervision data. The infrastructure service layer is the key to supervise the orderly development of data cloud services in the region. Referring to the service model of cloud computing, the cloud computing infrastructure service layer is divided into three different types: IaaS (Infrastructure as a Service), PaaS (Platform as a Service) and SaaS (Software as a Service).

IaaS constructs virtualized supervisory data into isomorphic data resource pool (data resource



aggregation), storage resource pool (transparently providing virtual storage services for users) and computing resource pool (gathering virtual computing power of cloud computing for users in need), and encapsulates them into services for cloud users so that they can deploy and run any software, such as operating systems and applications, on the "cloud" by using "bare computer".

PaaS offers users with software development platform as a service such as mass education data management, parallel computing, education software operation and development, etc. QoS management is responsible for managing and supervising the quality of data services. Middleware helps users develop and integrate complex application software. Load monitoring engine is responsible for managing and controlling the platform's capabilities in education supervision services.

SaaS packages related software programs into software services for users, who can customize specific application programs and dynamically package data components, business components, text label components and other units as needed to create more practical regional data services.

#### 4.3.3 Educational supervision data cloud service supply layer

The educational supervision data cloud service supply layer plays a key connecting role in the framework: providing integrated data to the upper layer, while making full use of the virtualized cloud resources for the lower layer, which is the core component to complete the regional supervision data cloud service. Its attributes fully reflect the characteristics of "on-demand" service, and its supply chain can be detailed according to the characteristics and demands of different regions.

#### 4.3.4 Educational supervision data application layer

With the support of the supply layer, the educational supervision data application layer can provide personalized, diversified and visual data services for users at different levels by using the abundant data in the region. With the help of the cloud-based WEB service interface, it directly provides various business data of the cloud platform for the regional users (schools, educational and scientific research institutions, and functional departments in the region that need various supervision data), such as the latest assessment report of all counties under a city, and the open interface of corresponding services that are easy to access, etc. The educational supervision data application service adopts the modern data method in the service mode, and continuously improves the quality, benefit and efficiency of the regional supervision data in the cloud environment.

In addition to the core business mentioned above, the educational supervision application service can also be flexibly customized according to the individual needs of users, thus facilitating the data circulation and sharing among users in the region.

#### 4.3.5 Cloud layer

The cloud layer is essentially the user application environment access layer, which supports various terminal accesses such as laptops, PCs, iPads, smart phones and smart home appliances. This layer, via the three major networks (mobile network, internet, radio and television network), provides on-demand service, dynamic deployment and everywhere-available service environment for the functional departments, data providers and receivers in the region, and supports the innovation of supervision and evaluation model with regional characteristics.

#### 4.4 Analysis of the Characteristics of the Digital Framework for Regional Education Supervision

##### 4.4.1 Providing a panoramic view of digital regional supervision in cloud environment

In this framework, modularization and layering are adopted to simplify the process of regional supervision data deployment and service, which improves the reusability of data, helps to exert the overall effect of cloud computing technology in regional data collaborative construction and use, and lays an architectural foundation for multi-level resource collaborative co-construction and integrated sharing.

##### 4.4.2 Balancing multiple data needs

One of the purposes of digital sharing is to meet the diverse needs of specific users in the region for supervision data. Therefore, in the model, the digital education resources are refined into services with different granularity with reference to the functional level of cloud computing, taking into account the various needs of personnel of different levels and different institutions in the field of education management for supervision data, so that data demanders can flexibly select services according to their different needs.

##### 4.4.3 Good expandability

The model technically presents a customizable regional data sharing structure in the cloud environment, so the new technologies and specifications can be easily integrated into the model, which is helpful for the education supervision data developers or managers under the regional cloud platform to balance the current demand and future development in the shared planning.

## **V. PROSPECT FOR APPLICATION AND CONCLUSIONS**

China has witnessed the vigorous construction of cloud environment and education cloud. However, at present, education cloud is mainly used in the fields of teaching and scientific research, and there is little practice of education management such as education supervision based on cloud computing mode. The data solution based on cloud computing model can realize data call on demand and is convenient and flexible. Therefore, it is believed that the education supervision solution under cloud environment can be applied and popularized in practice in the near future.

The digital framework proposed in this paper is the best choice for educational supervision data solution under the cloud computing environment at present, because it has a global and macro perspective, takes into account the needs of all parties and is easy to expand. Of course, due to time and resource constraints, this scheme has no practical application feedback and only stays on the basis of the theoretical framework prototype, which has certain limitations. In the follow-up research, it is hoped that the scheme can be put into practice and tested in practice.

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