

# Strategies for Improving Data Literacy of University Teachers in The Era of Big Data

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**Abstract:** In today's era of rapid development of big data, coupled with the risk of epidemics faced, the education industry is facing great challenges. The rational use of big data combined with the Internet for online teaching has become a mainstream teaching method. Not only is the use of online education platforms such as MOOC and Ding Talk Learning Platform widely carried out, but new online education methods such as online virtual teaching and research rooms have also been spawned. This paper discusses the new teaching model in the context of big data, and explores in depth the improvement of teachers' data literacy, and finally summarizes and outlooks in the context of the current situation.

**Keywords:** Big Data, Online Education, Teacher Data Literacy, Teaching Models.

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## 1. Introduction

So far in late 2019, the world has witnessed an outbreak of Corona Virus Disease 2019(hereafter referred to as COVID-19). Due to the highly contagious nature of COVID-19, the rapid outbreak in a short period of time has disrupted people's work, life and studies worldwide. As the outbreak continued to spread, people in some countries and regions had to strictly adhere to "home quarantine" measures to stop the spread of the virus, which not only affected the resumption of work and production, but also deeply affected the resumption of schooling for students. However, students will eventually return to campus, and the impact of the epidemic cannot be a reason for the original teaching content to stagnate. Schools and faculty members have exhausted all means to seamlessly integrate traditional education with online education, and big data analysis and decision-making in education has become an important force in promoting the development of educational reform and innovation. As the key subject of educational reform and innovation, teachers should not only have solid professional knowledge and strong information technology education ability, but also have the skills of collecting, organizing, analyzing and processing data in the education process, and the ability to use data effectively and promote teaching decisions. That is, in the era of big data, data literacy becomes a necessary skill for college teachers and puts forward newer requirements for teachers' professional development ability. However, although universities and teachers in China have a lot of data, they have long provided data mainly to the education administration, playing the role of "data provider" rather than "data user". Teachers lack the ideas and methods to effectively use and interpret information to help make decisions.

Many developed countries have begun to focus on the development of teachers' ability to use data to improve teaching and learning, and have put forward various views on the concept and connotation of data literacy, and have begun to enter the stage of practical research to construct models to support teachers' improvement of data literacy and to apply the models to practice. Harvard University proposed the Data Literacy Improvement Process (DWIP model) [1]; Mandinacci [2] proposed the "Data to Knowledge

Continuum" model; Marsh et al. designed a guiding framework for Data Driven Decision Making (DDDM) [3] to intervene in teachers' teaching practices, etc. Although foreign researchers have provided more systematic research and practice on teachers' data literacy competencies, they are still largely in the exploratory stage, especially because they lack a complete framework for the specific competency components of teachers' data literacy and cannot accurately assess the effectiveness of teacher training in a reasonable way. Domestic research on data literacy has just started, and most of the published literature is about data literacy education in colleges and universities, the necessity of data literacy, the introduction of practical experience and research results in foreign colleges and universities, and the research on the mode and strategy of data literacy development. In terms of teachers' data literacy competence development, a complete idea has not yet been formed, and it is at the initial stage of theoretical exploration, lacking a practical competence framework, evaluation system, enhancement scheme, and application practice model. Therefore, in the context of the epidemic, big data also has extraordinary and unique applications in the field of education; there are higher requirements for the new ecological construction of university teaching and the improvement of teachers' data literacy.

Based on the above analysis, it is urgent for college teachers to quickly improve their data literacy ability in the context of big data, to use data to improve teaching contents and teaching methods, to carry out personalized education for students, to improve teachers' teaching level and to enhance teaching effectiveness. To this end, Section 2 of this paper analyzes the traditional teaching mode from the development and change of teaching mode; Section 3 discusses the data literacy of teachers in the context of big data from four aspects: (1) the relationship between the formation of teachers' data literacy and online education; (2) the problems faced by teachers' data literacy improvement in colleges and universities; (3) the target requirements for teachers' data literacy improvement; (4) the response strategies of colleges and universities for data literacy improvement; and finally concludes with a summary. Finally, we conclude and present the outlook.

## 2. The Development and Change of Teaching Mode in The Context of Big Data

The rapid development of science and technology and the Internet industry has brought people into the era of big data. All fields of social development are filled with the backdrop of information technology. Terminal service providers can thus obtain a large amount of user information data, which is an unprecedentedly large source of data, and big data hides great wealth. And these data for example: blogs, photos, emails, phone calls, bank cards, internet in this unstructured form, are the daily life traces of people. With the help of some big data analysis tools and techniques, this large amount of data can be analyzed to find some useful information. Because of these characteristics of big data, combined with curriculum teaching, it will definitely become a powerful tool for curriculum teaching reform and will be the cornerstone of modern and better education model. Therefore, a large number of scholars at domestic and abroad are deeply studying the practical application of big data and curriculum teaching, improving teachers' data literacy, and exploring new curriculum teaching mode based on big data analysis technology has become an inevitable trend.

### 2.1. Changes in the traditional teaching model

The global outbreak of the COVID-19 has caused a major impact on global activities in many fields, including school education, with approximately 1.4 billion learners in nearly 162 countries facing the dilemma of not being able to attend school for classroom learning. At the same time, a large number of schools are replacing daily classroom education with online education, and the use of online education platforms incorporating big data has become mainstream during the epidemic. With the widespread use of online education combined with big data, various countries have issued decrees to regulate online education and improve various aspects of traditional online education. China issued the "Implementation Opinions on Regulating Off-Campus Online Training" at the same time as the 2019 epidemic struck, a regulatory document that addresses public concerns about teaching content, institutional fees, teacher qualifications, operating norms, information security, and other issues by proposing rules for rectification. The Ministry of Education has also taken the lead in establishing a daily inspection and sampling system, building a national off-campus online training management service platform, and establishing a black-and-white list of APPs, effectively addressing the negative impacts arising from online education and advancing the development of online education in China. In July 2020, the National Development and Reform Commission and 13 other departments jointly issued the "Opinions on Supporting the Healthy Development of New Industries and New Modes, Activating the Consumer Market to Drive the Expansion of Opinions on Employment" proposed to vigorously develop integrated online education. Build a mechanism for the regular integration and development of online and offline education to form a positive interaction pattern. Encourage more investment and teacher training, pilot classroom teaching based on online intelligent environment, and deepen the popularization of the "three classrooms" application.

Big data technology itself has great advantages, and the combination with course teaching in the information era has become a hot spot in the course teaching reform of colleges

and universities. Promoting the use of big data technology in curriculum teaching reform has become a trend in the current new situation, which requires universities to continuously improve the existing way of collecting curriculum teaching data and broaden the scope and means of applying big data technology in curriculum teaching. Big data technology can be applied in characterizing heterogeneous data and parsing data to obtain a large amount of useful information, thus a big data knowledge base can be established. The combination of big data technology and online teaching platform has become a far-reaching practice in curriculum teaching reform. Recent online teaching platforms, such as the flipped classroom [4], rely heavily on online activities and big data technologies. To this phenomenon of fixed teaching ideas, single teaching methods, and backward teaching hardware in current course teaching, Ying Liu et al [5] used big data for Internet analysis and explored a personalized IRDC (Internet + retrieval of literature + big data + cloud) course teaching model by combining different characteristics of students. In order to improve the pedagogical efficiency of the course teaching, and to address the drawback that the huge scale of the data itself in the traditional teaching model is prone to errors and data loss, Süleyman Eken [6] developed an exploratory teaching program for big data analysis, which aims to familiarize students with the key techniques for storing, using, and analyzing big data. The epidemic has put hundreds of millions of teachers and students on a path of online teaching completely removed from the reality of the classroom, which has brought rapid development opportunities for online education in China. According to data released by iiMedia Research (Figure 1), the online education market size has exceeded \$400 billion in 2019, and the epidemic has further accelerated the market education, which is expected to reach \$800 billion by 2025, with a CAGR of 11.4% from 2020 to 2025.



Figure 1. China's online education market size and its growth rate

### 2.2. The rise of big data-based course teaching models and platforms

A record number of students worldwide are unable to continue normal school life due to the COVID-19 pandemic. According to UNESCO (United Nations Educational, Scientific and Cultural Organization) monitoring, some 200 countries have implemented nationwide school closures as of 2021, affecting approximately 1.575 billion students, or 91.3% of all students enrolled globally. Also affected by the new crown pneumonia epidemic, 1,454 universities in China have launched online education, with 1.03 million teachers offering 1.07 million online courses. Almost all colleges and universities have moved their courses online. Through the

combination of mobile devices and network technology, online education will coexist with traditional education, providing more educational choices, promoting educational equity and educational innovation. In the general environment

of the COVID-19 epidemic, online education is now a norm, and online teaching models and educational platforms are coming back to the stage, as shown in Table 1.

**Table 1.** New online teaching models and educational platforms

Category	Feature
Voov Meeting	High definition and smooth, convenient and easy to use, safe and reliable
DingTalk	Book meetings, video conferences, post tasks, etc
MOOC	Create and provide widely available materials and conditions for participatory learning
LMS	For managing, documenting, tracking, reporting and delivering educational courses, training programs or learning and development programs
ZOOM	Easy to use
Skype	Instant messaging software, which has the functions required for IM, such as video chat, multi-person voice conference, multi-person chat, file transfer, text chat, etc.
WhatsApp messenger	Application for smart cell phone users, supporting Android, IOS and other systems, with push notification service
Virtual Teaching and Research Room	To build a new grassroots teaching organization system with multiple disciplines, types and levels, and to promote the network and systematization of virtual teaching and research rooms in a step-by-step manner, with application as the main focus

### 3. Research on Teachers' Data Literacy from The Perspective of Big data

The rapid development and progress of the Internet and 5G broadband make it possible to co-build, share and interact with each other in real time. In particular, online teaching has become an important way and means of teaching in special periods. With the global epidemic of COVID-19, schools will use big data for online teaching and learning. In order to improve the teaching quality of online teaching, the school factor can improve the teaching quality by improving teaching resources and teaching conditions, enriching teaching organization and teaching contents and improving students' ability through independent and team learning. Of course, teaching effect is not only related to objective hardware level, but also the soft power such as data literacy of university teachers is equally important. Optimize the online teaching database to achieve high-quality online teaching quality big data, so as to obtain better teaching quality and continuously improve teachers' data literacy, forming a virtuous circle[7]. By improving teachers' data literacy and continuously enhancing the professionalism and comprehensive ability of university workers, it will be beneficial to the future education of universities where big data is everywhere, and even the intelligent development of social education mode and the information development of education environment.

#### 3.1. The relationship between the formation of teachers' data literacy and online education

The essence of Big Data in education is the data quantification of the information generated by teachers in the teaching process, and its creation allows teaching to move from quantitative expansion to qualitative change. Data

literacy is the ability to accurately observe, analyze and process a variety of data that is constantly changing on the basis of comprehensive collection and aggregation. Teacher data literacy is one of the core literacies of teachers in the era of big data, which mainly refers to teachers' full use of various types of data information in daily activities based on certain teaching and educational objectives[8]. In the traditional teaching era, teachers' instructional decisions were usually based on deductive methods guided by theory and inductive methods summarized by experience. In today's era of big data in education, teachers' instructional decisions can be based on their own data literacy and meaningful big data to drive innovation and development of teaching and learning. Online education drives teachers to break through the inherent experience of teaching, to achieve data recording and analysis of student learning, to grasp the learning situation of students, and to accurately predict the trend of teaching. Online teaching using big data to achieve teacher teaching quality assessment has also become a new way. The actual teaching effect of online education in the new context also plays a vital role in assisting the future development and improvement of online education and the improvement of teachers' data literacy[9][10]. Thus, schools should effectively strengthen the application of new technologies, which requires teachers to continuously improve their data literacy, to be interconnected and interactive in the advancement of curriculum teaching, to integrate and advance, and to create teaching practice paths that combine online and offline, so that students can learn both in offline classes and through online videos that have been recorded for efficient and convenient learning.

Big data statistics show that in the actual education and teaching activities, the teaching decisions adopted by teachers often depend on their personal past teaching experience and are also influenced by external environmental factors such as students and parents, and the collection of teaching

information becomes a key factor in the teachers' adoption of teaching decisions and determines the subsequent teaching and education effects. In the teaching process, due to many factors, teachers' teaching decisions show reliance on empiricism, broad and imprecise teaching objectives, reliance on subjective judgment in teaching design, and lack of scientificity in teaching evaluation. Under the environment of big data in education, discovering the real problems in teaching through data mining and improving teachers' data literacy are the real needs for improving teaching quality. The big data processing center is established through academic data, teaching diagnosis, classroom observation, and deep learning to form an academic evaluation and teaching

platform for teachers' education and teaching, as shown in Figure 2. This education evaluation platform is richer and more reasonable in terms of evaluation results than the traditional education evaluation methods, and it establishes a monitoring system including physical education and health, art, information, and science by integrating a big data platform. Based on this, the data can be reasonably counted and interpreted to promote and deepen data-based evaluation of education and teaching. Research has shown that improving teachers' data literacy through technologies related to big data, such as online education, is an ideal way to solve the problem.

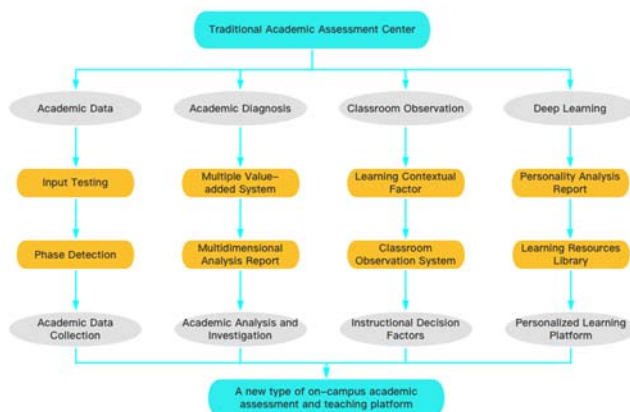


Figure 2. Evolutionary development of faculty teaching services

### 3.2. Problems Facing the Improvement of Data Literacy of College Teachers

#### (1) Low faculty data awareness

In some European countries, where the development of scientific and technological information technology is more sound, the data awareness formed in the whole society slowly evolves into a culture. Government education on data literacy development at different levels for different educational groups has greatly enhanced the data literacy awareness of the whole population, and even more so in universities. There are still more gaps in the cognition of data awareness cultivation in China, the cultivation goal of data literacy education is not clear, the level to which the skills of data literacy will be cultivated is not clear, which leads to the lack of systemic data literacy education, the content of data literacy lectures and related projects in the process is even more lack of standards, the lack of close cooperation among institutions in the school, each working on its own. The weak awareness of data literacy leads to the slow development of data literacy education. In the era of big data, college teachers need to be more perceptive, constantly discover data, analyze data and use data, and cultivate data literacy awareness.

#### (2) Lack of data resources

Data resources are the cornerstone for improving data literacy among university faculty[11]. Insufficient data resources and poor openness and sharing of data resources have also created difficulties for effective data access. At present, data preservation and management services in China's universal universities are just starting, and data literacy cultivation is still in the exploratory stage. Data-based databases in China are mainly concentrated in the financial and fiscal fields, while the storage of other types of data such

as educational, scientific, and observational experimental data is very weak. More government statistics and not fully disclosed, sometimes it is difficult to get the required information. In addition, a series of problems, such as unknown data sources, difficult to guarantee data accuracy, and slow data update, make the data quality poor and more difficult to meet the use of existing university teachers.

#### (3) Scarcity of professional talents

Data assets are the lifeblood of social development, and the biggest constraint to using big data technology to reach the strategic goals of enterprise and education development is the lack of data literacy professionals. Talent is one of the challenges brought by big data. Research shows that during the four years from 2011 to 2014, China's big data was in its infancy, with an annual growth of more than 20%. In 2015, the market size of big data has reached 9.89 billion yuan. In 2016, the growth rate reached 45%, more than 16 billion yuan. It is expected that in 2020, the size of China's big data market will exceed 800 billion yuan. In the next 3 to 5 years, China needs 1.8 million data talents, but as of now, there are only about 300,000 big data practitioners in China; in the past three years, the number of artificial intelligence positions in global enterprises has increased 8 times, but the future still presents a considerable gap. Under the continuous development of big data era, the desire for high data literacy talents in colleges and universities will be higher and higher. Therefore, universities must increase recruitment and talent retention efforts, while vigorously investing in the education and training of key data personnel and continuously expanding the team of high quality professionals in order to solve the problem of improving the quality of university teachers.

### 3.3. Teachers target data literacy enhancement requirements

#### (1) Enhanced Data Awareness

Highly data-aware teachers will collect, process, analyze, and explore the potential value of the information they come across in daily instructional management. Developing teachers' data awareness is a prerequisite for improving their data literacy. Data awareness requires teachers to increase their sensitivity to data, to be adept at discovering correlations between different information, and to accept the value criteria for data-based instructional decisions. The awareness of data literacy is gradually enhanced by continuously exposing to information and using data information from life and teaching practice.

#### (2) Improve data analysis capabilities

Teachers should continuously improve their ability to operate data analysis on the premise of mastering basic data analysis methods, and proficiently use various functions of office software such as classification, sorting, summarization, and chart generation. In the case of difficulty in mastering data clustering algorithms, classification algorithms, regression and other data mining algorithms commonly used in big data, take the initiative to communicate with experts in related fields to understand their basic principles. Decompose redundant data to make its organization clear and the relationship between data information clear.

#### (3) Improving data for teaching decisions

The teaching decision in the era of big data should gradually change from "empiricism" to "data-driven", teachers should adjust teaching strategies according to different students' learning status and make full use of big data to meet students' individual needs. By predicting and evaluating the teaching practices of students at different levels, teachers can determine effective teaching programs and improve data-based teaching decisions.

### 3.4. Strategies to address data literacy improvement in higher education

#### (1) Improve related policies to improve the general environment of education

Policy leadership is the threshold marker for raising awareness. To improve teachers' data literacy, it is most important to improve relevant policies and strengthen guidance, promote the establishment of a data management system, improve the general educational environment, and get rid of the existing dilemma. Universities should establish a multi-dimensional comprehensive intelligent evaluation based on big data to accurately assess the performance of teaching and learning, and incorporate data-driven teaching decisions into the examination system of teachers' professionalism evaluation. The Ministry of Education promulgated the "Standards for Teachers' Educational Technology Competence (Trial)" in 2004, which was the first evaluation standard for teachers' competence in China, and in 2013, the Ministry of Education launched the "Project for Improving Information Technology Application Competence of Primary and Secondary School Teachers" and issued the "Standards for Information Technology Application Competence of Primary and Secondary School Teachers (Trial)" in 2014. It has been used since then, which has greatly improved the IT literacy of teachers in China. In order to meet the iterative development of information technology, the

Ministry of Education implemented the "IT Application Ability Enhancement Project for Primary and Secondary School Teachers 2.0" in 2019. With the rapid development of big data, policies to improve teachers' data literacy should also evolve with the times to enhance teachers' information awareness, strengthen teachers' data manipulation skills, and build teachers' mindset to ensure that teachers are competent for future educational work.

#### (2) Strengthen teachers' data literacy education training and publicity to enhance data thinking

Data literacy and data thinking cannot be formed overnight, but require continuous accumulation of learning to achieve the effect of continuous use. Universities should actively organize training activities for teachers on data literacy to strengthen their understanding of data literacy and enhance their ability to control the use of data. The training activities guide teachers to change from individual "data-driven" teaching decisions to team-based data mining, data analysis and data expression. Teachers can also strengthen team building through training and learning, create a good academic data atmosphere on campus, and conduct data literacy promotion activities through self-media platforms such as WeChat and Weibo to strengthen data thinking and apply data literacy knowledge to all aspects of life and work.

#### (3) Build a professional data support system and improve the data literacy enhancement education platform

Data support system is a necessary platform to enhance data literacy reform fight. At present, the relevant data management platform of universities mostly serves the administration of user organizations and is less used for academic teaching. Convenient data support system and quality data education platform can save educational resources and improve work efficiency. Resources can be shared by building high-quality teaching success stories in colleges and universities, and the index data required for teachers' teaching can be optimized, greatly reducing the pre-workload of teachers in acquiring and applying data and reducing intermediate redundant links. Through the data literacy improvement education platform for college teachers, it is convenient to exchange data use experience and efficiently explore the educational time of data literacy application.

## 4. Conclusion

Universities are the platform and cradle for training high-quality talents, and teachers' data literacy is a comprehensive practical literacy essential for teachers' education and teaching in the era of big data. Under the background of big data, huge amount of data information is used in teaching, and the requirements for teachers' data literacy in colleges and universities are getting higher and higher. The research on data literacy of domestic university teachers should be carried out continuously, the core elements of data literacy should be proposed by using big data analysis method, the data literacy ability evaluation system should be constructed by using network hierarchy analysis method, and then the multi-level strategy of data literacy training for university teachers should be proposed by using the engineering project management method, and the training program should be adjusted dynamically by applying it to the teaching practice of our university, and then it should be continuously improved and extended to other institutions to provide a practical training

model for the improvement of data literacy of university teachers in China.

## Acknowledgment

Hebei Education and Teaching Reform Project (2017GJJG110).

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