



Research on the Influence of Information Technology on China's Higher Education in the Post-epidemic Era

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Abstract. The development of information technology has added new vitality to the teaching work of colleges and universities. This article mainly discusses the influence of information technology on higher education in the post-epidemic era and proposes relevant countermeasures. In the post-epidemic era, information technology promotes the personalized and international of higher education, enriches the diversity of teaching methods and promotes the transformation from “blended” to “double-blended”. Simultaneously, we construct a student performance analysis and prediction model based on regression forest, and verify the effectiveness of the model in a real dataset, which illustrates how information technology represented by big data and data mining is integrated with higher education to bring a new teaching experience. Finally, this paper also puts forward some relevant strategies on the future development of online education.

Keywords: Information technology · Higher education · Regression forest · Post-epidemic era

1 Introduction

At the beginning of 2020, COVID-19 has brought a huge impact and unprecedented challenges to traditional higher education. Under this circumstance, online education has provided new solutions for the development of teaching in colleges and universities. According to the statistics of MOE of China, in the spring semester of 2020, all ordinary undergraduate colleges and universities in China implemented online teaching, 1.08 million teachers opened 1.1 million courses, and 22.59 million college students participated in online learning [14], which is an unprecedented large-scale online education experiment. During the epidemic, the impact on higher education has reached an unprecedented level.

MOE of China issued a notice in August 2020 requiring schools to fully resume teaching [8], marking the arrival of the post-epidemic era in education. The post-epidemic era refers to an era in which epidemics rise and fall from time to time, and small-scale outbreaks may occur at any time [11]. During this period, the epidemic returns from

foreign countries and has the characteristics of seasonal outbreaks. Therefore, although colleges and universities have fully resumed offline teaching in the post-epidemic era, it does not mean that online teaching has withdrawn from higher education, on the contrary, in the post-pandemic era, information technology will be further integrated with higher education and have a profound and lasting impact on all aspects of higher education.

In the post-epidemic era, the impact of information technology on higher education is reflected in various aspects. First, information technology promotes the personalization of higher education. Second, information technology promotes the international development of higher education. Third, information technology is conducive to improving the teaching practice of higher education. On the one hand, information technology can increase the diversity of teaching methods in higher education. 5G technology digitizes teaching resources [6, 7], big data and data mining personalize teaching methods [1, 5, 9], and artificial intelligence technology makes teaching process intelligent [2, 13]. In this paper, we construct a student performance analysis and prediction model based on regression forest, and verify the effectiveness of the model in a real dataset, which illustrates how information technology represented by big data and data mining is integrated with higher education to bring a new teaching experience. On the other hand, information technology promotes the transformation of higher education teaching mode from “blended” to “double-line blended”. Based on the above analysis, at the end of this paper, countermeasures are put forward for the development of online education in Chinese universities in the post-epidemic era.

2 Information Technology Promotes the Personalization of Higher Education

In the post-epidemic era, information technology and higher education are highly integrated, breaking the previous teaching model where knowledge could only be imparted and received in the classroom. From the perspective of educational resources, through network information technology, electronic resource information such as university libraries and databases are all connected to the network. These personalized online resources provide college teachers and students with choices and increase the autonomy and subjectivity of learning. From the perspective of college teachers, online education has the characteristics of education individualization and liberalization, which enables college educators to maximize the realization of teaching students according to their aptitude through information technology. From the perspective of college students, the integration of information technology and higher education enables college students to obtain information anytime, anywhere. The learning location is no longer confined to the classroom, the learning time is more flexible and autonomous, and the learning content can be completely determined by the students.

In the post-epidemic period, colleges and universities will continue to transcend time and space constraints and give teaching a wider range of time and space freedom. Mingyuan Gu pointed out that learning society pursues the fully development of individuals through individual learning and lifelong learning [4]. In the post-epidemic era, the information literacy of citizens has been significantly improved, and the lifelong learning ability of individual students has been significantly enhanced. It is more conducive

to the establishment of a Chinese learning society, which will reflect the individual and social functions of higher education to a greater extent.

3 Information Technology Promotes Internationalization of Higher Education

3.1 Solve the Cross-Border Flow Difficulties Caused by COVID-19

Clark Kerr believes that the essence of the internationalization of higher education is the internationalization of knowledge and academics, which is mainly manifested in the international flow of knowledge, scholars and students [3]. Thanks to information technology, information exchange and educational activities are not technically restricted by national borders and regions. With the development of information technology, real-time machine translation technology may be realized in the near future. The emergence of practical computer real-time translation means that language barriers on the Internet will be completely eliminated, people can freely obtain information in different languages on the Internet, and people in different languages can communicate freely [10]. It can be seen that international exchanges without leaving home are possible. In the post-epidemic era, information technology will be further integrated with the internationalization of higher education, solve the geographical restrictions caused by the epidemic, and provide technical support for the further development of China's higher education internationalization.

3.2 Change the International Value Orientation of Higher Education

Before the epidemic, international education only existed among overseas students. For a long time, people regard the internationalization of higher education as the movement of people, especially the movement of students. The development of information technology has made the "local internationalization" of higher education possible. "Local internationalization" of higher education has two characteristics. One is that internationalization takes place in the home country, and the other is the internationalization of the curriculum [15]. This means that students can accept international courses in their home countries or even their own schools, and can overcome various obstacles caused by the epidemic or other reasons for cross-border movement of people. At the same time, it can also expand the audience of internationalization of higher education, so that more ordinary college students can access international courses through information technology. So information technology in the post-epidemic era has greatly solved the problem of cross-border flow of people and expanded higher education. This enables the public to fully experience the connotation of the internationalization of higher education.

4 Information Technology Improves Teaching Practice in Higher Education

4.1 Increase the Diversity of Teaching Methods

In the post-epidemic era, information technology has changed the traditional teaching method in which teachers stand on the podium and students passively accept it. As

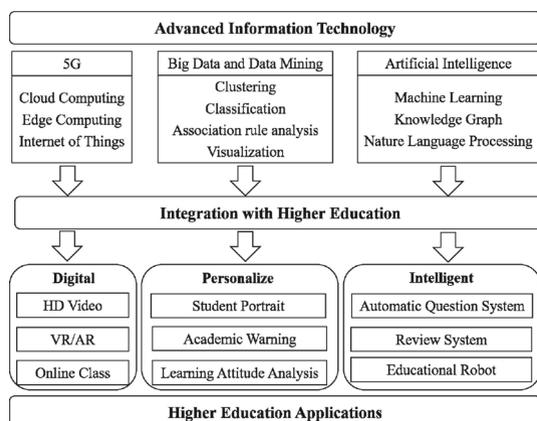


Fig. 1. Application of Advanced Information Technology in Higher Education.

shown in Fig. 1, advanced information technologies like 5G, virtual reality, augmented reality, big data, data mining, and artificial intelligence are developing rapidly, and their integration with higher education has brought new teaching methods and experiences.

5G can realize the sharing of higher education resources and improve the quality of online teaching. The lower latency and higher transmission speed of 5G provide a strong network foundation for the wide application of VR/AR technology, bringing students an immersive teaching experience. Through the analysis and mining of multi-source data of students, big data and data mining can accurately describe the multi-dimensional portraits of students in academic, life, social, psychological, practice and other fields. Teachers can use student portraits to create high-quality personalized teaching for students. For students, student portraits can help them understand their weak points in learning and identify their own strengths and weaknesses, so as to carry out adaptive self-directed learning. In addition, in the post-epidemic era, the integration of artificial intelligence and higher education has become increasingly mature. A number of typical applications of intelligent education have emerged, such as automatic question generation systems based on knowledge graph technology, automatic review systems developed based on natural language processing technology, and so on.

In the following, we take the regression forest model to predict student performance as an example, and explain in detail how information technology represented by big data and data mining technology can be integrated with higher education in the post-epidemic era to provide teachers and students with personalized and intelligent teaching services.

4.1.1 Big Data and Data Mining + Higher Education—Taking the Student Performance Analysis and Prediction Model Based on Regression Forest as an Example

With the development of information technology, data is accumulating at an unprecedented speed, and the world has entered the era of big data. In higher education, a large amount of educational data will be generated, which has become one of the most valuable resources for educational analysis. Utilizing data mining technology, we can extract

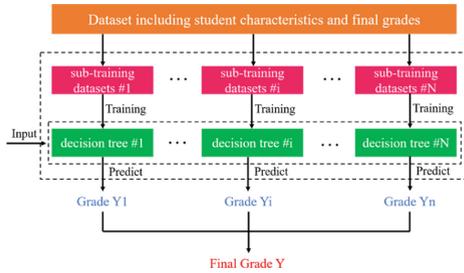


Fig. 2. Student performance prediction model based on regression forest.

meaningful and valuable teaching and learning information from educational big data resources, and apply them to education and teaching according to the actual teaching situation. By predicting students’ future learning behaviour, we provide each student with a personalized learning plan to achieve the goal of optimizing teaching effects.

A typical application is to collect the relevant characteristics of students’ study habits, social relations, daily life, etc., to mine the correlation between these characteristics and students’ learning performance, and finally achieve the purpose of predicting students’ final test scores.

The correlation between features and test scores can be quantified by the Pearson correlation coefficient, as shown in Eq. (1). We define a feature set $X = [X_1, X_2, \dots, X_i, \dots, X_n]$, where X_i represents the i -th feature of the student, such as the number of class attendance, alcoholism, after-school study time, etc. The variable Y represents the academic performance.

$$\rho_{X_i, Y} = \frac{cov(X_i, Y)}{\sigma_{X_i}, \sigma_Y} \tag{1}$$

where $cov(X_i, Y)$ is the covariance of variables X_i and Y , and σ_{X_i} is the standard deviation of X_i . A result close to 1 indicates that the feature represented by X_i has a more significant impact on the student’s academic performance, and a result close to 0 indicates that the feature is not related to the student’s academic performance.

The prediction of student performance can be achieved by constructing a regression forest model. Regression forest is an ensemble learning method. By training multiple weak models and packaging them to form a strong model, the performance of the strong model is much better than that of a single weak model, thereby improving the prediction accuracy. The training and prediction process of the model is shown in Fig. 2.

In the training phase, the dataset including student characteristics and final grades is divided into several sub-training datasets from 1-N to train multiple different decision trees. In the prediction stage, the regression forest averages the prediction results of multiple internal decision trees to obtain the final result.

The core part of the model is how to select partition features and partition feature values for each decision tree according to the sub-training dataset. The method we adopt is to traverse all the features and all the values of each feature in the data set, measure their quality by mean squared error (MSE), and select the most reasonable dividing features and dividing feature values.

Table 1. Student characteristics in the dataset.

school	mother’s education	travel time	activities	free time
sex	father’s education	study time	nursery	go out
age	mother’s job	failures	higher education intention	workday alcohol
urban or rural	father’s job	school sup	internet	weekend alcohol
family size	reason	family sup	romantic	health status
cohabit	guardian	paid	family relation	school absence

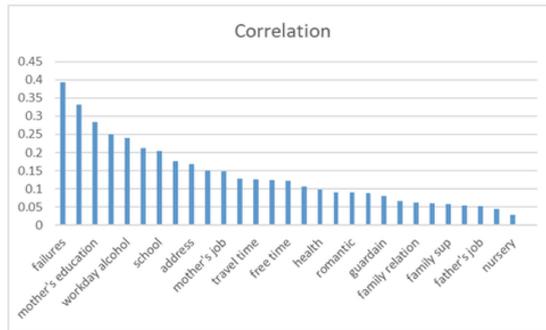


Fig. 3. Correlation results between student characteristics and final grades.

According to the above method, n decision trees are respectively constructed for the sub-training data set 1 to the sub-training data set N. For a student whose grades are unknown, by inputting several of his features into the model, n prediction results can be obtained, and their average value is the final predicted grade of the student.

4.1.2 Experiment and Model Application

We validate the model’s performance on an online public dataset. The dataset provides 30 characteristics of 649 students, as shown in Table 1, including demographic characteristics, social characteristics, and school-related characteristics, etc., as well as students’ grades.

The correlation between each feature and the student’s grade is calculated by Eq. (1), the result is shown in Fig. 3.

From the results in Fig. 3, we can find that the five factors that have the greatest impact on students’ performance are the number of failed subjects, whether they want to receive higher education, mother’s education status, after-school study time, and the number of drinking times on weekdays. The five least influential factors are family educational support, parent’s cohabitation status, sex, extra-curricular activities, and whether attended nursery school. Based on the analysis results, teachers and students can adjust the teaching content and rhythm, focus on the teaching points that can improve

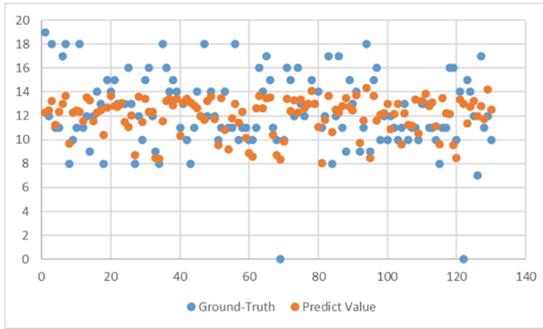


Fig. 4. Comparison of predicted and ground-truth student grades.

academic performance, and supervise students in a targeted manner, thereby improving the teaching effect.

We also verified the effect of the regression forest prediction model on this dataset, dividing the sample data of 649 students into a training set and a prediction set, hiding the students' grades in the prediction set, and comparing them with the output results predicted by the model. The results are shown in Fig. 4.

It can be seen from Fig. 4 that the model can obtain a more accurate prediction effect. By predicting student grades, teachers can determine whether the student may have a learning crisis. If there is a learning crisis, students can be reminded in time and given timely intervention guidance. Finding students' academic difficulties in the early and mid-term of the course and making timely interventions can improve the course pass rate and final graduation rate of college students.

4.2 Promote the Teaching Mode from Blended to Double-Line Blended

After entering the post-epidemic era, online teaching is impossible to completely disappear, and it will not be completely replaced by offline teaching. They will continue to be more scientifically combined. Some scholars have submitted that in the post-epidemic era, school education will enter the new era of "double-blended". Unlike "blended" teaching, "double-blended" teaching is not a simple combination of online teaching and offline teaching, but a "fusion thinking", which means that they will interact with each other. Promoting students' comprehensive development as a logical starting point, connecting the information technology and university course resources, will promote the deep integration of education teaching values and information teaching techniques in the post-epidemic era. Combined with the above concepts, SPOC mode will be discussed here.

4.2.1 Concept of the SPOC Mode

SPOC means Small Private Online Course, which is a new online teaching mode proposed by Amando Fox. The SPOC model is designed for students, they will be divided into small classes according to their professionals and learning foundation, and each

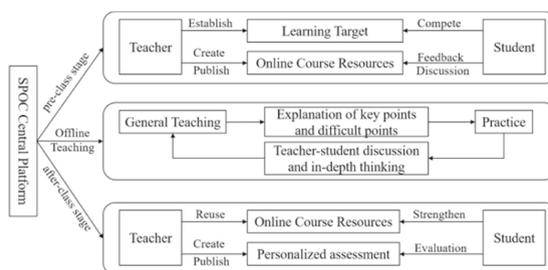


Fig. 5. SPOC teaching mode.

class is generally no more than 30 people. This makes it more conducive to the full combination of online and offline teaching to achieve the purpose of mixed teaching. The essence of SPOC mode is to combine high quality MOOC courses and classroom teaching.

4.2.2 Highlight the Characteristics of SPOC as the “Double-Blended” Teaching Mode

Since the SPOC mode is proposed relative to MOOC, there is a significant feature of the following points through the MOOC.

First of all, there is significant difference in nature. MOOC is an online teaching mode, and SPOC is combined with online education and entity class, which is a kind of “double-blended” teaching mode. SPOC is an improvement of MOOC’s teaching content, teaching form, educational concept and technology platform, so that the MOOC course can apply to a solution for different learning groups [12].

Second, the group users are also very different. MOOC has no class-out restrictions as a large-scale online course, which can provide online courses for large-scale people, while as a private online course, SPOC provides online courses for tens to hundreds of small-scale groups, which also adds sustainability for the development of SPOC.

4.2.3 Improve the Implementation of SPOC Teaching

As shown in Fig. 5, The SPOC mode can be divided into three stages: online self-learning before class, explanation of key and difficult points in class, expansion and consolidation after class.

In the pre-class self-study stage, teachers publish learning tasks and related knowledge online, provide optional learning resources, and establish learning goals. Students conduct self-directed learning online by reading relevant texts and watching videos. At the same time, students can take advantage of online resources to choose courses across schools, express their learning thoughts, ask relevant questions, interact with teachers and classmates, and summarize the knowledge points they have learned in the online discussion area.

In the traditional offline teaching stage, teachers focus on solving the major and difficult learning points efficiently based on the performance and feedback of students in the pre-class stage. In addition, teachers can take advantage of offline classrooms to

carry out hands-on activities such as experiments, calculations, and drawings. In the face-to-face learning process, students are guided to think deeply about the learning content, which overcomes the indifference of online learning and the inefficiency caused by the difficulty of concentration.

In the expansion and consolidation stage after class, on the one hand, learning resources such as teaching videos and texts can be used online for unlimited times, and students can review the content that they have not fully mastered or forgotten. On the other hand, by publishing personalized after-class exercises to evaluate students' learning effects, not only can students know how much knowledge they have mastered, but also help teachers understand students' weak points and give targeted explanations in subsequent teaching.

5 Countermeasures for Online Education in Chinese Universities in the Post-epidemic Era

5.1 Colleges and Universities Need to Establish the Correct Concept

From the perspective of colleges and universities, they should fully recognize the opportunities brought by COVID-19, pay extensive attention to online education, and actively promote the deep integration of information technology with higher education.

5.2 Build Rich Teaching Resource Systems

In the post-epidemic era, it is necessary to build a rich teaching resource system for online education in colleges and universities, which mainly includes the construction of curriculum resources and platform resources. The construction of curriculum resources is the basis for carrying out double-line blended teaching, which directly affects the effect of double-line teaching. At the same time, in order to improve the quality of online teaching, colleges and universities should also pay attention to the construction of platform resources. First of all, colleges and universities should not only provide relevant learning support services, but also simultaneously improve the informatization construction of teaching management and evaluation systems. Secondly, the poor network of the teaching platform seriously affects the quality of teaching. We should increase the expansion of the teaching platform and improve the stability of the network to ensure the smooth progress of online teaching.

5.3 Improve Students' Self-learning Ability and Self-control Ability

How to cultivate the self-learning and self-control ability of college students is a training goal that needs to be particularly strengthened in online and offline integrated teaching, and it is one of the key elements that determines the success of double-line blended teaching. However, most students generally lack this ability. Therefore, more attention should be paid to these issues in the teaching design process of the double-line blended teaching mode. It is necessary to fully consider how to combine online learning with classroom learning in order to stimulate students' interest and improve their learning efficiency.

6 Conclusions

During the outbreak of COVID-19, information technology provided strong technical support for “suspending classes without stopping school”, enabling China's higher education to achieve unprecedented development in the post-epidemic era. In China, information technology has promoted the individualized and internationalized development of higher education, greatly improved the teaching practice of higher education, increased the diversity of teaching methods, and promoted the teaching mode from “blended” to “double-line blended”. In order to promote the high-quality development of online education in the post-epidemic era, colleges and universities can start from the perspectives of establishing correct concepts, building a rich teaching resource system, and improving students' self-learning ability and self-control ability. Next, information technology will further promote the accelerated integration of higher education into the information technology era, enabling higher education to continue its development.

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