Deep Learning-Based University-Assisted Management Solution for Public Health Emergencies

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Abstract. Once a public health event spreads in schools, it will affect the stability of families, schools and even society. Therefore, timely adjustment of student management strategies in colleges and universities is important for students' physical and mental health, teaching activities and epidemic control. Based on the 4R crisis management theory, this paper summarizes and analyzes the problems and reasons for universities to deal with the epidemic; proposes the solution of artificial intelligence-assisted university management in three aspects: precise control of personnel movement, campus security and establishment of epidemic emergency system; and proposes the solution of campus intelligent construction to guarantee the scientific operation of epidemic safety management, taking into account the actual situation of domestic universities. The seminar will provide reference experience for universities.

Keywords: artificial intelligence · public health events · university management · 4R crisis management theory · campus intelligence · epidemic security mechanism

1 Introduction

"COVID-19 shows us that having a good, robust health management program is critical," said Dr. Bloomfield, former Director General of Health in New Zealand, at the February 20–24, 2023, revision of the International Health Regulations [1]. As a special kind of public place, colleges and universities have a strong aggregation and a wide range of exposure. According to the National Statistical Bulletin on Education Development in 2021, there are 3012 general colleges and universities with 44.3 million students, and the average number of students per school is 16,366. With such a scale, once a public health event occurs, it is very likely that the epidemic will spread rapidly in schools, thus affecting the stability of schools, families and even society. Therefore, it is important to study the management strategies of universities during public health events for students' physical and mental health, teaching activities and epidemic control.

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In the 21st century, with the rapid development of artificial intelligence technology, 5G, big data mining and other new technology intensive outbreak, showing deep learning, cross-border integration, human-machine collaboration, group intelligence open, autonomous manipulation and other new features. In this epidemic prevention and control, the role of artificial intelligence has been initially seen, concentrated in many areas such as information collection, personnel management, resumption of work and production. In colleges and universities, using AI to promote the level of intelligent campus management and help colleges and universities cope with emergencies is an important means to ensure the stable operation of colleges and universities during public health events.

1.1 Concept of Public Health Events

According to the definition of the Sudden Public Health Regulations, public health events are: major infectious disease outbreaks, mass unexplained diseases, major food and occupational poisoning, and other events that seriously affect public health that occur suddenly and cause or may cause serious damage to the public health of the community [2]. According to the outbreak and prevalence of infectious diseases and the degree of harm, infectious diseases are also divided into three categories: A (plague, etc.), B (tuberculosis, etc.), and C (mumps, etc.) [3]. A public health event in this article refers to an outbreak of a communicable disease that may spread in a university.

1.2 4R Crisis Management Theory

4R crisis management theory is a concept first proposed by American crisis management scientist Robert Heath in his book "Crisis Management", as shown in Fig. 1. Through crisis management and crisis prevention measures, we can reduce the loss caused by crisis in three dimensions: before, during and after. How to deal with crises? Robert gave the four models of crisis reduction management (Reduction), crisis preparedness management (Readiness), crisis response management (Response), and crisis recovery management (Recovery), namely the 4R model, which became the basic principles of crisis management [4].

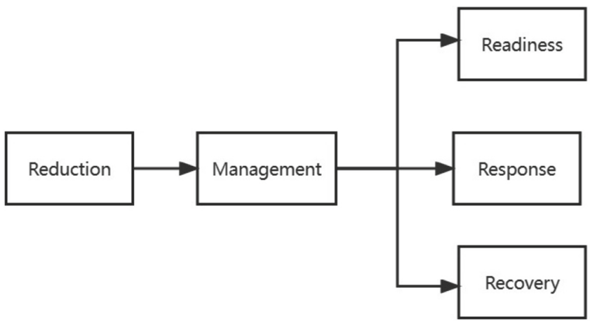


Fig. 1. The 4R theory of crisis management

Crisis reduction management focuses on the external environment, structural organization, internal systems and personnel management in order to reduce the impact of a crisis.

Crisis preparedness management mainly refers to the construction of early warning and monitoring mechanisms. When a crisis occurs, the adverse effects of the expansion of the situation are suppressed at the root, including: monitoring and warning, issuing early warning signals, and activating response systems.

Crisis response management, mainly refers to the actions and measures taken by management after a crisis occurs. Crisis response requires managers to do a good job of all response measures, from crisis event investigation, public relations management, solutions and communication and other aspects of a comprehensive consideration, to provide a solution template for different organizational structures to deal with unexpected crisis events, following the steps of confirming the crisis, isolating the crisis, dealing with the crisis and summarizing the crisis.

Crisis recovery management, mainly refers to the closing work after the crisis is over, including: addressing the negative impact of dealing with the crisis, the convergence of follow-up work, and the summary of crisis management work.

1.3 Current Status of Artificial Intelligence Applications During Epidemics

Since the outbreak, the country has been actively using artificial intelligence, big data, cloud computing and other advanced technologies to provide technical support for epidemic monitoring and analysis, virus tracing, prevention and control, rescue and treatment, and resource deployment, taking advantage of China's strengths in big data and artificial intelligence applications.

First, the use of big data to track the development dynamics of the epidemic, the establishment of a joint prevention and control mechanism, the sharing and sharing of big data on epidemic telecommunications, and the disclosure of data from relevant departments such as health, civil aviation, transportation, and railroads, allows artificial intelligence to analyze and predict the direction of the epidemic, identify high-risk groups, potential high-risk groups, and potential risk groups, and conduct accurate screening, prevention, and monitoring.

Second, para medicine to improve the efficiency of rescue and research. Artificial intelligence based on big data and other medical-related technologies to assist or accelerate the judgment and treatment of confirmed cases; the use of intelligent robots to reduce the burden on doctors and avoid cross-infection of personnel in tasks such as the distribution of meals, living supplies and medical supplies in isolation wards.

2 Problems Exposed by Universities Responding to Public Health Events

Universities, as units vulnerable to epidemics, have traditionally been the focus of public health event prevention and control. Because the epidemic is characterized by easy infection and long duration, there are still many problems although all levels pay great attention to it. In this paper, we take some colleges and universities as examples, and analyze the situation of colleges and universities in response to public health events from two levels: prevention and control management and student subjects.

At the level of prevention and control management, the main manifestation is that the prevention and control mechanism for responding to public health events needs to be improved. First, there is insufficient information sharing, poor coordination and implementation of various departments, poor information interface with local governments, education authorities and foreign affairs management departments, and poor integration of regular campus management and emergency management, which reduces the efficiency of epidemic prevention and control work. Secondly, front-line student managers (counselors) take up too many management affairs and the number of students is too large, the information management means is single, the authority and responsibility are not equal, and the job responsibilities are blurred, which leads to excessive psychological pressure and brain drain of counselors, and the implementation of epidemic management measures is not in place, etc.

At the level of students, the two main aspects are the need for psychological counseling and weak crisis awareness during the epidemic. In addition, although the student-centered education concept is advocated now, in the actual management process, most universities regard students as the control objects and ignore their subjective feelings, and some management policies and measures are easily resisted or even resisted by students, resulting in low efficiency and poor overall effect of epidemic prevention and control.

3 Analysis of the Causes of the Problem

Based on the 4R crisis theory, this paper will analyze the reasons behind the epidemic prevention and control problems in universities from four stages: crisis reduction management, crisis preparation management, crisis response management, and crisis recovery management.

3.1 Inadequate Information Collaboration

From the perspective of crisis reduction management, the core problem of inadequate information coordination is the imperfection of legislation. To reduce the generation of crisis and the negative impact brought by crisis, crisis reduction management needs to start from the environment, structure, system and personnel to coordinate the whole crisis management work, and the key is to have the law to follow. The reality is that there is very little university legislation for the management of college students during the epidemic, except for the Regulations on Public Health Emergencies, the Law of the People's Republic of China on Prevention and Control of Infectious Diseases and the Ministry of Education Deploying Education System to Prevent and Control Pneumonia Infected by New Coronavirus for this NCP epidemic, there is no targeted legislation for the education system.

From the perspective of crisis preparedness management and response management, emergency management lacks assessment drills. College administrators mainly focus on the visible level of school construction, such as campus hardware construction, discipline system construction, foreign exchange and cooperation and other tangible construction, and the lack of attention, awareness, investment and construction of college student safety management is also an important reason for the current dilemma faced by college management.

3.2 Loss of Frontline Student Managers During the Outbreak

The reason for the loss of front-line student managers during the epidemic is the counselors' own lack of position identification. Analyzed from the perspective of crisis reduction management, it is that in the university campus where teaching and research is the main theme, the social status of college counselors engaged in ideological and political education and management is still relatively low, and their work is often not fully understood and respected, leading to weak professional awareness and negative professional mentality of counselors.

3.3 Disconnection Between Psychological Guidance and Students' Psychological Stress Response

The psychological stress reactions of college students to varying degrees during the epidemic led to the need for psychological counseling among students. Studies in the literature show that during the NCP epidemic, college students had varying degrees of psychological stress reactions, including 15.4% with depressive mood deviation and 6.4% with obsessive-compulsive-anxiety mood disorder [5]. The widespread prevalence of NCP and the sudden, rapid transmission and lethality of NCP have led to a series of psychological reactions among college students, which in turn have led to various emotional problems [6].

4 Artificial Intelligence-Based Campus Epidemic Management Solution

Aiming at the outstanding problems in the management of college students during public health events, this paper proposes practical management countermeasures and construction solutions based on artificial intelligence technology in three aspects: precise control of college personnel, campus security, logistics guarantee and establishment of epidemic emergency system.

4.1 Multimodal Fusion of Infrared Thermography and Image Recognition for Accurate Monitoring of Human Body Temperature

Infrared thermography technology has long been widely used in military and border inspection because of its non-contact, non-sensitive and fast screening characteristics. In this epidemic, infrared thermography body temperature detection technology quickly became the preferred solution for rapid screening of people's body temperature.

To implement accurate prevention and control of epidemic, for the crowded scenes in universities, not only infrared thermal imaging technology is needed to screen out abnormal body temperature, but also to track down specific objects, such as face tracking, license plate recognition, and real-name travel. Therefore, multimodal fusion (Multimodal Fusion) of infrared thermal imaging detection and deep learning-based image recognition methods is performed to make information data such as body temperature and management objects correspond, in order to form accurate control of epidemic.

4.1.1 Basic Principles of Infrared Imaging

Infrared thermal imaging temperature measurement principle is based on Planck's law of radiation as the theoretical basis, the use of photoelectric conversion of the measured object surface thermal radiation energy into infrared detector output level signal, the electrical signal and the detector received by the radiation energy can be expressed in the following equation [7]:

$$V_s = W(\lambda, T)A_0\tau_0R \tag{1}$$

Among them, the V_s, A_0, τ_0 and R are the level signal of the IR detector output, the effective aperture of the optical system, the transmittance and the optical system responsiveness, respectively; W, λ, T are the radiation energy received by the infrared detector, the wavelength and the surface temperature of the measured object. Where:

$$W(\lambda, T) = \int_{\lambda_1}^{\lambda_2} \varepsilon(\lambda, T, \theta)C_1\lambda^{-5}/(\exp(C_2/\lambda T) - 1)d\lambda \tag{2}$$

Among them, the ε, θ are the target emissivity and orientation angle, and C_1, and C_2 are the first and second radiation constants. For the same infrared thermal imaging thermometer, the spectral bands and A_0 and τ_0, and R are fixed, so V_s and T is a one-to-one correspondence.

Generally speaking, the data obtained from the thermal imaging thermometer contains image information of different gray levels, and the surface temperature of the measured target can be determined by finding the gray level as a function of the level signal by means of calibration (Fig. 2).

According to Kirchhoff's law of radiation, at a certain temperature, a black body is the object with the strongest radiation capability and can be called a complete radiator. In the real world, there are no objects that completely transmit, reflect, or absorb incident radiation, but black bodies have been scientifically created that absorb about 97–99% of the radiation and are mostly used for calibration in infrared thermography for body temperature screening.

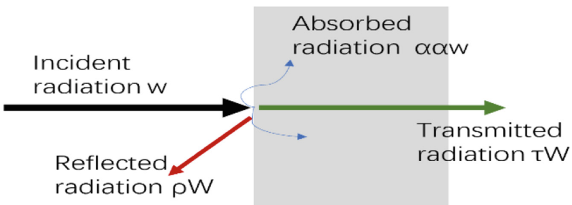


Fig. 2. Radiation principle of blackbody model

4.1.2 Principle of Deep Learning Based Image Recognition

Image recognition refers to: the technique of using computers to process, analyze and understand images in order to recognize targets and objects of various different patterns, and a series of technical means to enhance and reconstruct images of poor quality, so as to effectively improve image quality. Figure 3 shows the different levels of tasks such as recognition, detection, segmentation and understanding of image recognition.

At present, the target recognition technology based on deep learning of artificial intelligence is advancing rapidly, and the recognition efficiency and accuracy are far beyond the classical image recognition methods, and the more advanced and popular ones are Faster-RCNN, ssd, YOLO, etc.

The basic units of neural networks for deep learning-based image recognition are convolutional neural networks and residual networks. Convolutional Neural Network (CNN) is a kind of neural network that incorporates convolutional operation and pooling operation, and the structure of convolutional neural network proposed by Lechun earlier is shown in Fig. 4.

The convolution operation is as follows:

$$s(t) = (x * w)(t) \tag{3}$$

where the first parameter x of the convolution is the input, the second parameter w is the kernel function, and the output is called the feature mapping, Fig. 5 shows the 3 × 3 of the convolution operator.

The essence of the pooling operation is sampling. Pooling takes the input Feature Map and chooses some way to compress it. For example, for values in the field of a Feature Map, selecting the maximum value to output to the next layer is called Max-Pooling.

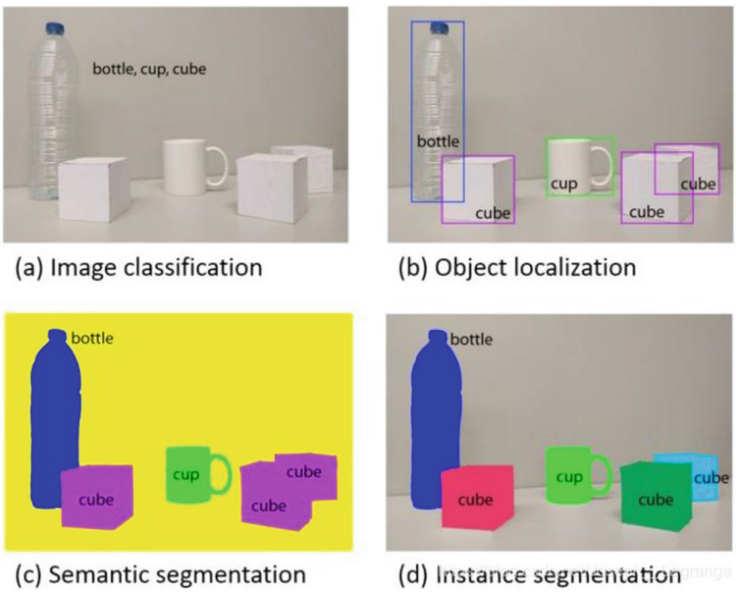


Fig. 3. Recognition, detection, segmentation and understanding tasks for image recognition

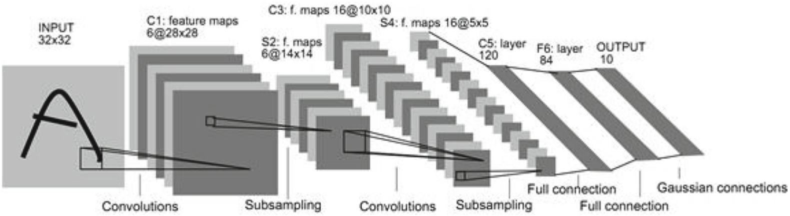


Fig. 4. Structure of LeNet5 network and its process of feature extraction [8]

-1	0	1
-2	0	2
-1	0	1

Fig. 5. 3 × 3 Convolution operator

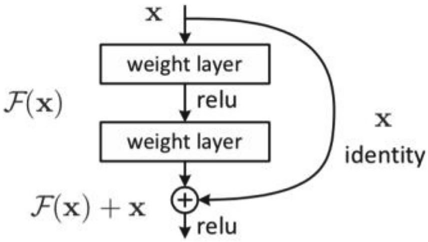


Fig. 6. Residuals module

The idea of residual networks originated in the paper [9]. The residual network lets the nonlinear layer satisfy $H(x, \omega_h)$, and then introduce a short connection directly from the input to the output of the nonlinear layer, so that the whole mapping becomes

$$y = H(x, \omega_h) + x \tag{4}$$

The residual module is defined as shown in Fig. 6:

The residual network can better fit the classification function to obtain higher classification accuracy, and solves the difficulty in optimizing the training of the network when the number of layers is deepened.

4.1.3 Multimodal Fusion

Multimodal fusion techniques in deep learning [10] (MFT) is the process by which a model processes different forms of data in accomplishing analysis and recognition tasks.

The fusion of multimodal data can provide more information for model decision making, thus improving the accuracy of the overall decision results. Multimodal fusion includes three types of architectures: Joint, Coordinated, and Encode-Decode [11]. The three types of fusion architectures are widely used in many fields such as video classification, sentiment analysis, speech recognition, and involve the fusion of image, video, speech, and text.

4.1.4 Design Framework for Campus Epidemic Management Program

The overall architecture of this scheme includes 4 parts, the first part is the acquisition and processing of infrared images, the second part is the acquisition and pre-processing of video images, the third part projects the infrared thermal imaging information and video information into the joint semantic space, and the fourth part is the training and image recognition by deep neural network, the specific technical architecture is shown in Fig. 7 below.

Using big data technology to integrate epidemic and other travel data, build one file for one person in the college population, integrate public security chokepoint data, human-vehicle combination, key area vehicle management, real-time control of vehicles, to achieve accurate positioning of abnormal body temperature personnel, key people can be controlled and traced, mobile trajectory can be tracked and predicted, from external to internal prevention, from point to surface prevention, real-time data management of epidemic information, scientific and accurate to help real-time prevention and control of epidemic in colleges and universities. The epidemic information is managed in real time.

4.2 Multi-intelligence Based Campus Security Logistics Solution

A multi-intelligent system is a collection of multiple intelligences, and its goal is to build large and complex systems into small, easily managed systems that communicate and coordinate with each other [12]. Its research deals with the knowledge, goals, skills, and planning of the intelligences and how to make the intelligences take coordinated actions to solve problems. Researchers focus on interactive communication, coordinated cooperation, and conflict resolution among intelligences, emphasizing close group cooperation among multiple intelligences rather than the autonomy and exertion of individual capabilities, and mainly illustrating how to analyze, design, and integrate multiple intelligences to form mutually collaborative systems.

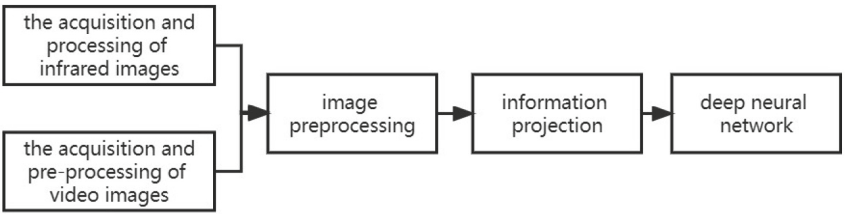
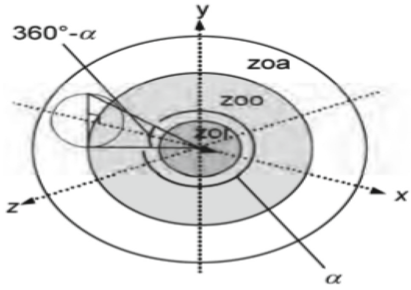


Fig. 7. Design framework of the campus outbreak management program



(a)

Fig. 8. (a) Perceptual area division of individuals

4.2.1 A General Model of Group Intelligence

The group intelligence takes the discrete form of cluster motion, where N individuals in the cluster move at a constant rate s. The equation of state of motion of the individuals [13] is

$$\overrightarrow{v_i}(t+\Delta t) = \mathrm{rand}\left(\overrightarrow{d_i}(t+\Delta t)\right) \tag{5}$$

$$\overrightarrow{r_i}(t+\Delta t) = \overrightarrow{r_i}(t) + \overrightarrow{v_i}(t+\Delta t)s\Delta t \tag{6}$$

where $\overrightarrow{d_i}(t+\Delta t)$ indicates $t+\Delta t$ the time i the desired direction of the vector; rand(∗) is the random perturbation introduced to the vector corresponding to the SAC rule, the perceptual area of individuals is divided into three non-overlapping parts from inside to outside, the repulsion domain (zor), the formation domain (zoo) and the attraction domain (zoa), as shown in Fig. 8(a), where the repulsion domain has high priority and only collision avoidance motion is activated when individuals appear in this region; otherwise, the formation and aggregation motions take effect at the same time, and individuals move in the same direction as the formation domain individuals in the attraction domain while converging to the same direction of movement as the individuals in the attraction domain, Fig. 9 (b)-(e) shows four forms of swarming, vortex, loose translational and consistent translational swarming motions. The rule can be expressed as follows:

$$\overrightarrow{d_i}(t+\Delta t) = \begin{cases} -\sum_{j\in N_i^{zor}} \frac{\overrightarrow{r_{ij}}(t)}{\|\overrightarrow{r_{ij}}(t)\|},\ N_i^{zor} \notin \varnothing \\ \sum_{j\in N_i^{zor}} \frac{\overrightarrow{r_{ij}}(t)}{\|\overrightarrow{r_{ij}}(t)\|} + \sum_{j\in N_i^{zoo}} \frac{\overrightarrow{v_j}(t)}{\|\overrightarrow{v_j}(t)\|},\ N_i^{zor} \notin \varnothing \end{cases} \tag{7}$$

4.2.2 Technology Application

Traditional campus inspections are time-consuming and labor-intensive, and take up valuable human resources during an epidemic. During this epidemic, 5G/4G network-based patrol robots were used in many places for mobile infrared temperature screening, mask wear detection, cyclic broadcast shouting, remote visualization command, and other management control functions such as real-time robot status control, robot

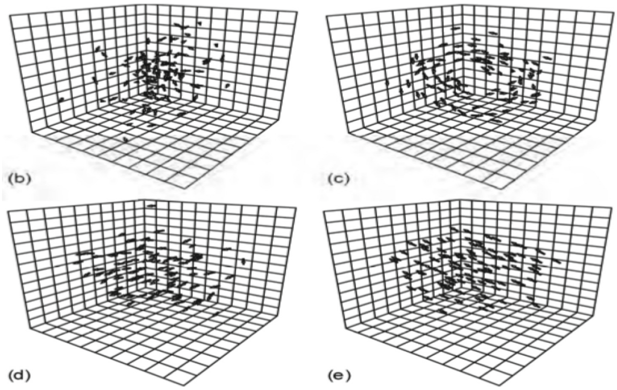


Fig. 9. (b)-(e) Four forms of cluster motion: swarm, vortex, loose advection and uniform advection

inspection task management, data query statistics, video collection, and electronic map construction.

4.3 Campus Intelligence and Epidemic Prevention and Control Security Mechanism Construction Synergy

The construction of epidemic prevention and control security mechanism should make full use of big data and cloud platform combined with artificial intelligence technology to provide accurate analysis and intelligent research and judgment for university student management in 4R stage, and provide timely and effective auxiliary decision-making information for epidemic prevention and control security management [14].

4.3.1 Strengthen the Integration of Big Data System Construction

Universities need to make full use of the national information and data sector resources and establish a safe and sound personal data integration center with the help of enterprises or self-built cloud platforms. Implement an online punch card system to grasp basic information, whereabouts dynamics, distribution and other data of teachers and students in real time, with real-time updates and dynamic management. Through the statistical analysis of the big data system, the daily epidemic prevention and control data analysis report is formed to provide scientific auxiliary decision-making data for the epidemic prevention and control security mechanism to guarantee timely control, precise management and intelligent control of the epidemic.

4.3.2 Rely on Campus Security Platform to Take Advantage of Artificial Intelligence Technology

The scenarios of epidemic prevention and control in higher education institutions include school gates, cafeterias, dormitories, administrative offices, teaching areas, family areas, school hospitals and comprehensive training sites [15]. According to the actual situation of the school, for the school gates and other crowded places, temperature measuring guns and green code pass are used for strict management of personnel; for crowded places, infrared temperature measuring cameras are used for timely screening of abnormal body temperature; for outdoor and teaching places, campus drone inspection and video surveillance are used to identify those who are not wearing masks and timely through epidemic safety mechanism by collecting facial characteristics information of teachers and students Reminder.

4.3.3 Deep Integration of Online and Offline Resources

Based on cloud service technology, integrate the school's high-definition multimedia hardware terminals and introduce a remote video platform to guarantee the stable development of online meetings and online teaching. Promote fewer meetings, online meetings and short meetings to ensure smooth scientific operation and management, and adopt online teaching mode for courses with large numbers or cross-college. Optimize online databases, libraries, online classes and virtual experiment centers and other resources to ensure that faculty and students can quickly switch to the online teaching and office work mode under emergency conditions.

5 Conclusion

Epidemic prevention and control is a highly integrated and systematic work, and emergency decisions often occur under conditions of interdepartmental and interdisciplinary fields, complex data, uncertainty and even missing information. The safety and stability of college campus is the fundamental guarantee of high-quality development of higher education institutions. With the development of universities and changes in social environment, coping with the impact of public health events has become a new issue for university management, and the great destructive power of public health events has posed new challenges to the existing prevention and control system of universities. The proper application of intelligent information technology can greatly improve the perception, decision-making, response speed and quality of emergency organizations, enhance work efficiency and management capability, and reduce congestion points and danger. To break through the traditional prevention and control system for responding to public health and safety, to constantly update and improve it in theoretical research and practice, and to explore a scientific and systematic prevention and control system for responding to public health events in line with the actual situation of universities, requires the joint efforts of the state, universities and others.

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