Design and Implementation of Online Education System Based on Microservice Framework

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Abstract—The online education system based on microservice framework designed in this paper is to further subdivide the system into more independent modules, each module has its own independent function to avoid excessive coupling of the system, making the function of each module more clear and easy to manage. From the perspective of business logic, the system includes user module, education module, payment module, backend module, advertising module and third-party interface module. The system is mainly for students and back-end administrators, including the front-end learning system and back-end management system. The microservice architecture in this paper is mainly implemented using Spring Cloud framework.

Keywords— Online education, microservice framework, Design.

I. INTRODUCTION

On February 25, 2022, CNNIC released the 49th "Statistical Report on the Development Status of China's Internet". According to the Report, as of December 2021, the number of Chinese Internet users reached 1.32 billion, an increase of 42.96 million compared with December 2020. Transportation, environmental protection, financial services, health care, education and other service industries are increasingly integrated with the Internet, and the level of Internet services has shown characteristics such as intelligence and meticulousness.[1] The level of network services is becoming more intelligent and detailed.

The benefits of online education to traditional teaching are as follows. First, with online education, students can confirm their opinions in a teacher-to-teacher interaction. This method of teaching disrupts traditional teaching methods by providing knowledge outside of the classroom. Teachers provide students with greater freedom to choose the most appropriate method of acquiring new knowledge, bringing it into the classroom and increasing the efficiency of student-teacher interaction and communication [3]. Second, when using the Internet for teaching, both teachers and students have access to the vast data resource base of the cloud classroom. Teachers can enrich their classroom teaching by using the cloud classroom data resource base, and students can access and cite content they do not understand by using the cloud classroom data resource base [4]. Third, the Internet-based education model enables unified planning of education, and the role of the Internet makes high-quality educational content play its greatest role and impact. Fourth, the learning process is organized in an Internet environment, so that the location of the educational institution, regardless of the location of the student, does not prevent quality training. Distance learning is based on the principle of independent preparation of lessons by students through teacher guidance, allowing the choice of convenient class times. It includes interactive communication between teachers and students, information resources of the educational institution and the Internet, and rapid delivery of information resources in electronic form on the Internet.[5] The distance learning is based on the principle of independent preparation of lessons by the instructor.

II. CURRENT STATUS OF DOMESTIC AND INTERNATIONAL RESEARCH

At the beginning of the 21st century, online education in North America, Europe, Japan and Korea have all developed to varying degrees [6].

The creation of online courses in the U.S. came relatively early, and there is now a huge market for Internet-based educational enterprises in the United States. According to NC-SARA's most recent annual data report, in fall 2020, there was a 93 percent increase in new students pursuing full distance education at 2,201 SARA-participating institutions, bringing the total number to nearly 6 million, and a 144 percent year-over-year increase in distance education enrollment at public institutions. Nearly 60 percent of SARA institutions participating in the survey said they plan to continue to offer some or all of their distance emergency services in the form of online learning after the new crown epidemic pandemic. This report not only provides a snapshot of the dramatic changes that occurred for students and teaching institutions during the 2019 coronavirus disease (COVID-19) global pandemic, but also provides lessons that can be learned for the future of online learning education for learners worldwide. Until today, essentially all U.S. high-performing institutions have established their own online education websites, and the entire U.S. education system is gradually improving [7] The entire U.S. education system is gradually improving.

As a result of the New Coronavirus outbreak, the education community in Europe has been hit like never before, and many in Europe are turning to online teaching. In fact, there are some countries that are also promoting online education. Future Learn, a MOOC platform developed by the Open University in the UK, went live in 2013 [8]. This platform offers a lot of educational resources, covering tens of millions of people worldwide. Meanwhile, France has launched a similar platform France Unicersite Numberique and exists as the French university administration. Germany launched a MOOC platform in 2013 to provide educational services to local students.

III. SYSTEM FRAMEWORK

This paper mainly deals with the design and implementation of an online education system based on SpringBoot microservice framework, through which students can play educational videos and realize online teaching mode.

A. System Technical Architecture Design

The number of technologies used in this system is very large, in order to better visualize the technical architecture of the microservices framework.

B. Spring Boot Framework Analysis

Spring Boot is an open source micro framework developed and maintained by Pivotal to simplify the building of Spring applications. [11] Spring Boot provides a practical integration framework for different microservice architectures [12]. Other components can be merged with very little file structure and comments. Compared with Spring, you can reduce the complexity of system configuration, making the development process more efficient and stable .

C. Microservice Framework Analysis

Microservices framework is simply a design style in system architecture. The main role is to split the original a complete service into many smaller modules, each module has its own independent function, the modules communicate with each other through http. Commonly used frameworks are Spring Cloud and so on.

D. Vue framework analysis

Vue.js is a simple and powerful JavaScript library , is an open source framework for Web front-end, to achieve software engineering projects in college development , and can shorten the delivery cycle for developers .[14] Vue uses a bottom-up framework model, it focuses on the top of the representation layer, is a lightweight framework, with many features and libraries, for many browsers are compatible . At the same time, Vue is very easy for developers to get started, as long as it is compatible with ECMAScript 5 features, then you can use this framework in your project.

Vue uses the MVVM model, which is optimized on the basis of the original MVC and MVP models, making it possible to achieve separate front and back-end development. ViewModel is the business logic layer, used for dynamic processing of the model, synchronized to the model when the view changes, and vice versa, when the model changes the corresponding view will also change.

Vue works by using Object.defineProperty to set each property of a Javascript object to the corresponding set or get method, accessing the property via get and modifying it via set. Vue can operate on them where they are not visible and notify when they are accessed or modified. Also Vue has a monitor object that recalculates and renders the relevant component when the set method is triggered, which is the core processing of Vue.

The system is developed using full-stack front-end and back-end separation, and the microservice framework is used to build the service cluster to guarantee the reliability of the system. Students enter the representation layer through the front-end page, send requests to the business layer and pass through the microservice gateway, which will query the interface address of the corresponding service through Nacos and send the request to the corresponding microservice module, then the corresponding module will process the request and return it to the front-end system, and the front-end interface will render the interface and display it to the students. The system uses a wide range of technologies, so it needs to be developed with attention to the link interaction between each component module.

IV. SYSTEM FUNCTIONAL MODULE DESIGN

This system is developed with separate front and back-end, front-end learning system and back-end management system. The front-end learning system is mainly for students, and its functions include login and registration, course center, instructor center, video viewing, online payment, personal center, Q&A, articles, etc.

The backend management system is mainly for administrators. Its functions include administrator module, advertisement management module, education module, SMS push module, OSS docking module, order module, statistics module, user module, video module, etc.

A. System Development Environment Design

The development of a system requires not only the design of technical functions and modules, but also a good development environment.

B. System database design

The system is designing different tables for various operations of students and administrators to meet the business requirements, and there are different relationships between each entity. This section will analyze these business relationships and elaborate on the table structure made for each relationship, and also perform data persistence operations to guarantee the proper operation of the program.

The online education system is mainly aimed at two kinds of users, one is students and the other is administrators. Students mainly login and register to enter the front education system, and pay online for their favorite courses, so that they can watch videos; the main operation of the administrator is to add and view courses and add and view instructors. In order to complete the above operations, the table structures are designed in the database.

C. Front-end Learning System Design and Implementation

One of the main functions that users have in this system is the login and registration function. Students can enter the correct information with cell phone SMS verification to successfully get an account. Access is done by entering the correct information or by scanning directly from WeChat.

In this system, there are two ways for students to log in, one is through account password and the other is through WeChat sweeping QR code to authorize login, mainly describing the scenario of WeChat sweeping code login. If the student enters by entering correct information, the back-end

receives the request and the verification is passed, then the login is possible. The password in the storage is encrypted by the message digest algorithm and needs to be decrypted when the password is verified. If the user intends to login through WeChat, after sending WeChat login request to the backend, the backend generates the url of WeChat authorization platform to redirect the user to the corresponding platform and scans the QR code for WeChat authorization, after successful authorization, WeChat will call back the callback function of the backend with code value, the backend requests accsess_token and openid from WeChat through the code value, after passing the If the user does not exist in the database, it will be saved in the database, and finally the user id and user name will be used to generate a token through JWT to return to the front-end, at which point the single sign-on will have been successful.

D. Course order and payment function

After the user has successfully registered and logged in, he can browse all the courses and details in this system. After seeing the course he likes, he needs to purchase it if it is not free, and then he can click the corresponding video to watch it.

After the user clicks pay now, the corresponding course order will be created, the order information will return and enter the order page to show the information to the user, the user confirms that there is no error, then click pay for online payment, the background will create the WeChat QR code payment url and redirect the user to this page, the user pays the corresponding fee by scanning the QR code. The front page will regularly send order inquiry requests to the backend to check whether the order has been successfully paid, if not, it will keep sending inquiry requests at 3s intervals within the specified time, if it has been paid, it will create a record of successful payment and return to the front end for successful payment, and the user will have the right to watch this video. The code used in the foreground to query the order status of successful payment is implemented as follows, the background by searching for the order number to get the map, through which you can see how the current state will react to various states, which can be used to determine the status quo.

E. Backend Management System Design and Implementation

One of the most important functions of the backend management system is the course add function, the course add is divided into three processes, the first is to enter the basic information of the course, after saving, you need to continue to enter the chapter and section information, and finally need to confirm the release, in the whole process involves not only the database storage, but also involves the Ali cloud video storage and oss image storage. Here is a detailed description of the entire process.

After the administrator click Add, the first thing you enter is the basic information to add. The course cover needs to be saved by uploading the image to AliCloudoss, not locally, AliCloud will return the image url, and the backend will save the url and basic information in the database. After saving the course information, enter the course outline interface, save the chapter and section, when creating the section you need to

upload the corresponding video, then you need to upload the video playback to AliCloud, return to the playback credentials, save the chapter information, section information and the corresponding video playback credentials. Finally, click to confirm the release, the course is officially completed to create.

V. SYSTEM TESTING

Before you start testing, you need to determine the system's operating environment, which is extremely important for testing. The environment used in the system mainly includes macOS, Mysql, JDK1.8 and Redis. The system is tested using black-box testing, so it is not necessary to care about how the intermediate processes are performed, but only to compare whether the final results meet the requirements. It is also necessary to combine the previous requirement analysis and functional development design to test the main functions comprehensively to ensure that they meet the user's requirements.

VI. SUMMARY

This thesis analyzes the current educational environment, which is not limited to offline education due to the epidemic and changes in teaching methods. At the same time, because of the microservices architecture, each module is relatively independent and easy to maintain and expand. When the system needs new features or introduces other new technologies, it is only necessary to develop another module and interface to the original system, without affecting the original framework code. The system has high reliability and availability. The system has achieved most of the functions and has the basic conditions for commercialization, but problems may still occur in the case of high concurrency, and the problems arising from the large number of users need to be further improved.

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