Design and Implementation of a Microservices-Based Online Learning Platform

XiaoKang Ren, Hong Wang(✉), and TianTian Cai

School of Computer Science and Engineering, Northwest Normal University, Lanzhou, China
480504496@qq.com

Abstract. In times of epidemics, students' learning is restricted and online learning becomes important. The aim of this paper is to establish a stable, functional and high-quality online teaching platform using micro services thinking. The process of this study includes an overall analysis of the platform and a description of specific functional implementation techniques. The functional modules of the platform are analysed and the system functional modules of the platform are obtained. The design and analysis of the platform's technology stack, the design of the front-end platform, middleware and back-end service technologies to form the overall technology stack, and the analysis of the differences and advantages of the architecture. The design and implementation of the platform has been applied in practice and has been well received by most, but there are also some shortcomings. To conclude, this research has achieved an efficient and stable platform build for students who are not comfortable with offline learning.

Keywords: Online learning platform developing · Microservice · Spring Cloud

1 Introduction

During the epidemic, local governments stopped offline gatherings and school learning was greatly affected as a result [1]. In order to carry out regular teaching and learning, institutions around the world have started to work in an online model. Online teaching mainly contains a variety of models, including Mooc, Live Course, Online-self-learn-course, Course on TV [2]. Suitable for teaching institutions is Online-self-learn-course, which includes the online learning platform provided by teaching institutions, course content composition, the biggest feature is the content. The most important feature is that the content and learning environment is completely controlled by the school or teacher. The online learning platform is a very important vehicle that supports student learning. The current school-owned online platform is characterised by low quality, low stability and imperfect functionality [3]. Therefore, the aim of this study is to build a stable, fully functional and high-quality online learning platform.

C. F. Peng et al. (Eds.): EIMT 2023, AHSSEH 8, pp. 455–460, 2023.
https://doi.org/10.2991/978-94-6463-192-0_60

2 Acknowlegements

2.1 Microservice

Microservices Architecture is a software development technology and a variation on the Service Oriented Architecture (SOA) architectural style1 [4]. It promotes the division of a single application into a set of small services that coordinate and work with each other to provide ultimate value to the user. Each service runs in its own separate process, and services communicate with each other using lightweight communication mechanisms (usually HTTP-based RESTful APIs).

2.2 Spring Cloud

Spring cloud is a service governance toolkit based on Spring Boot implementation for managing and orchestrating services in a microservices architecture [5]. Spring cloud is an ordered collection of frameworks. It leverages Spring Boot's development convenience to cleverly simplify the development of distributed system infrastructure, such as service discovery registries, configuration centers, message buses, load balancing, circuit breakers, data monitoring, and more, all of which can be launched and deployed with a single click using Spring Boot's development style.

3 Method

3.1 Functional Modules

The online learning platform is a platform to solve the problem of online learning, so to meet the needs of users, the following modules are needed: user registration, user login, purchase courses, watch videos online, check orders, view learning records, search courses, instructor module, course management, user management, evaluation, etc. The entire functional structure of the platform is shown in Fig. 1.

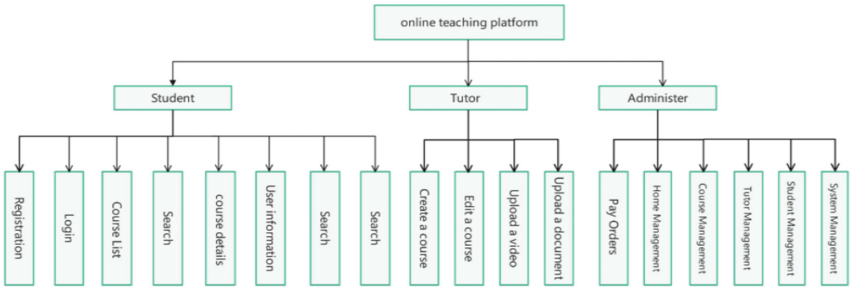

Fig. 1. Platform structure diagram [Self-drawn]

3.2 Platform Technology Stack

The main technologies used are the following: VUE framework and HTML5 are used to write user access pages. Keepalived is used to detect the status of web servers and exclude unserviced hosts. JSON is used to enable the correct delivery of message data across services. The back-end part consists of four areas, the control of the microservices, the specific services, the data part and the tooling services. The microservices are controlled by Nacos for service registration and discovery, Sential for access traffic control, and RabbitMQ for inter-service message shell control. Specific business is to implement project requirements, such as access to personal information, view courses, modify courses, upload videos and other service interfaces, involving specific technologies such as spring MVC, Spring The data section implements user access to personal information and videos, involving technology nologies such as Mysql, Tencent Cloud and Redis. Tool services include ELK for log search, SMS for user registration and Docker for project deployment (Fig. 2).

In the architecture, the user will enter the front-end page of the platform through the browser and a request will occur, and the back-end server will receive the request and respond to it. The response is a very complex process and it is not as straightforward to respond as the monolithic architecture. Requests need to go through a lot of technical service pieces before reaching specific services, such as Rabbit MQ to ensure the integrity of messages through the AMPQ protocol, Sential responsibility chain to ensure that the access server traffic is in a controlled range, and finally the service will carry out specific processing, such as access to the Mysql database, access to resources in Tencent Cloud, data computing, etc.

The distinctive feature of this stack is that the specific services are divided into individual Api, so the whole platform architecture is more decentralized, which provides convenience for later platform upgrade, expansion and adjustment, and likewise reduces the subsequent maintenance cost. The decentralized structure also improves the stability and availability of services.

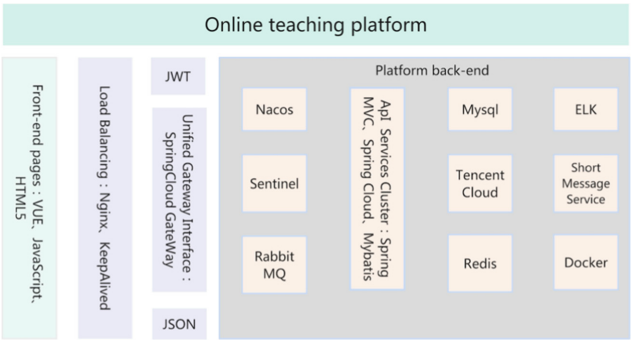

Fig. 2. Platform Technology Stack [Self-drawn]

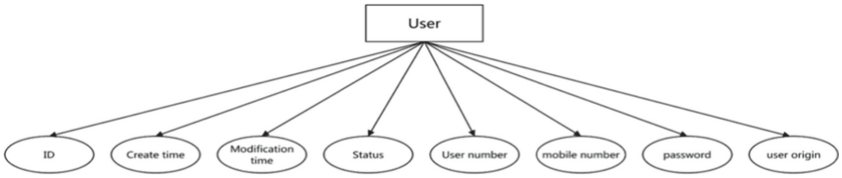

Fig. 3. User Table ER diagram [Self-drawn]

Table 1. User Table Structure

Field Name	Data type	Data length	Is Null	key	Remarks
id	Bigint		No	Key	
gmt_create	Date Time				Creation time
gmt_modified	Date Time				Modification time
status_id	Tinyint				1:available,0:Disable
user_no	Bigint				
mobile	Varchar	11			Phone number
mobile_salt	Varchar	36			Password salt
mobile_psw	Varchar	255			User Login password
user_source	Varchar	255			client_id

3.3 Database Table Design

The system is designed with a database containing basic information tables and several entity linked modelling tables. These tables are placed in a single database to speed up system access.

First create an ER diagram of the user table (shown in Fig. 3) with attributes containing user ID, creation time, modification time, status, number, mobile phone number, password, user source, etc.

Secondly, the creation of the user table is completed according to the ER diagram, the specific structure of which is shown in Table 1.

3.4 Specific Functional Implementation

Course Video Upload

The course video files are stored in Tencent Cloud, and the file upload is done by accessing the local file path and passing the local files to the File Bucket provided by Tencent Cloud; after the upload task is executed, the Api interface will return a JSON data to show whether the file upload is successful.

File localFile = new File("D:\\1.mp4");
String bucketName = "bucketName";
String key = "test-1.mp4";

```
SendSmsLog sendSmsLog = new SendSmsLog();
sendSmsLog.setMobile(req.getMobile());
sendSmsLog.setTemplate(sys.getSmsCode());
sendSmsLog.setSmsCode(RandomUtil.randomNumbers( length: 6));
boolean result = AliyunUtil.sendMsg(req.getMobile(), sendSmsLog.getSmsCode(), BeanUtil.copyProperties(sys, Aliyun.class));
if (result) {
    redisTemplate.opsForValue().set( k: platform.getClientId() + req.getMobile(), sendSmsLog.getSmsCode(),  t: 5, TimeUnit.MINUTES);
    sendSmsLog.setIsSuccess(IsSuccessEnum.SUCCESS.getCode());
    int results = dao.save(sendSmsLog);
    if (results > 0) {
        return Result.success(results);
    }
    return Result.error(ResultEnum.USER_SEND_FAIL);
}
sendSmsLog.setIsSuccess(IsSuccessEnum.FAIL.getCode());
dao.save(sendSmsLog);
return Result.error(ResultEnum.USER_SEND_FAIL);
```

Fig. 4. Sending SMS verification code [Self-drawn]

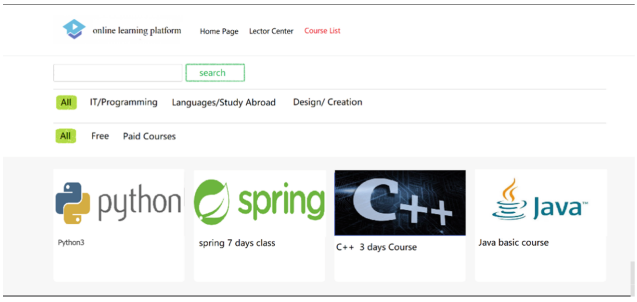

Fig. 5. The Platform's Homepage [Self-drawn]

PutObjectRequest putObjectRequest = new PutObjectRequest(bucketName, key, localFile);

PutObjectResult putObjectResult = cosClient.putObject(putObjectRequest);

System.out.println(JSON.toJSONString(putObjectResult));

User registration.

The core code implementation process of registration, through the user input mobile phone number, receive SMS verification code, through ajax request back-end interface to pass in parameters, back-end interface implementation code as follows (Fig. 4).

3.5 Result Presentation

He specific page presentation is shown below and fully achieves the intended functionality of the development (Fig. 5).

4 Conclusion

After the development of the platform was officially completed, it was deployed in a cloud server and feedback was collected from several users. Of these, over 70% of teachers and students gave positive feedback, while close to 30% of users and teachers mentioned that the user interface was not user-friendly enough to suggest, or that the functionality was not good enough, or that the access speed was not fast enough.

Overall, a highly available and efficient online learning platform has been designed and implemented by adopting a microservices mindset and approach. The main difference between it and the traditional learning platform is the introduction of microservices thinking, which makes the server easier to scale and the service more stable. The development idea of this learning platform can provide a reference for the development of other learning software.

From the user's point of view, it enables online learning for students and online learning for teachers, and can also help some educational institutions and schools to extend their learning tasks. In the context of the new crown epidemic, such a platform can provide a good help for learning and learning.

References

1. 1.Jin Suyan Zhao Agi Zheng Jing Hu Wang Shuang Wang Kun Zhimin Wang Xi Du Fan Jiangbo Huang Ruimei Haiping Qiu Wuqi 2023 Experience and insights of prevention and control of the new crown pneumonia outbreak in Shenzhen[J] Health Soft Science 37 01 77 81
2. Jiao Jianli Zhou Xiaoqing Chen Zexuan 2020 A case study of online learning and learning in the context of epidemic prevention and control[J] China e-learning 03 106 113
3. Xu Mei Jin Beneng 2022 Difficulties faced by the development of online education in China in the context of the epidemic and its coping strategies [J] Journal of Anhui Open University 01 22 25
4. YH Wang JS Zhang ANM Deng ZX Zhou 2016 Spring Boot research and application[J] Information Communication 10 91 94
5. Yanyuan Xin Jun Niu Zhijun Xie Kaile Zhang Xinyi Mao 2018 A review of microservice architecture implementation framework[J] Computer Engineering and Applications 54 19 10 17