



Research on the Application of Web based Online English Teaching Platform in Universities

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SUMMARY: *With the aim of providing personalized learning paths and targeted recommended learning resources for each student, this study is based on the web and designed for online English teaching platforms in universities. The hardware part of the platform is connected by multiple components through high-speed buses and network interfaces. The software part has designed a database that covers multiple roles such as students, teachers, and administrators, and has established a database permission management mechanism based on entities, attributes, and relationships. Based on the constructed database, the K-means clustering algorithm is used to standardize the Z-score of the original online English teaching data, and through clustering processing, student learning features are mined to achieve targeted recommendations. During the experiment, when 800 students were online at the same time, the page loading time of the platform designed in this paper was only 1.8 seconds, the memory utilization rate was 55%, and the CPU utilization rate was 72%. After applying the platform, the teaching effect satisfaction index was highly recognized, and the students' English learning performance improved steadily. In the comparison of interface response speed, the dynamic frame rate of the platform increased from 2.0fps to nearly 3.0fps, which was a significant advantage, indicating that the platform has high application value.*

KEYWORDS: *web; College English; Online teaching platform; K-means clustering; Personalized recommendation*

1 Introduction

With the continuous advancement of information technology and educational informatization, online English teaching platforms have gradually evolved into key supporting tools in college English teaching due to their inherent advantages such as convenience. This type of platform breaks through the limitations of traditional teaching in terms of time and space, providing students with personalized learning experiences and helping teachers expand the implementation dimensions and strategic means of teaching activities. However, current platform applications face challenges, such as inconsistent functional design standards, variable teaching quality, and deficiencies in personalization, interactivity, and data security. Research on their application is therefore of practical significance.

In existing research, Reference [1] studied the use of digital platforms for online teaching by college English teachers. In actual operation, there are problems such as complex platform operation and poor functional adaptability. Reference [2] introduced the functional modules

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of the platform in detail and analyzed the application effect of the platform. However, this study lacks in-depth discussion of the platform's personalized teaching and teacher-student interaction. Reference [3] analyzed the advantages of online teaching platforms in improving students' learning enthusiasm and learning effects by comparing traditional teaching and online teaching. However, this study ignores the needs of students for the platform during their extracurricular independent learning. Reference [4] built an interactive practice platform for mobile English teaching in colleges and universities based on open API. However, due to the differences in interface standards and data formats of different teaching systems, the platform faces technical difficulties in the integration process.

This paper combines literature and empirical research methods to explore the application of web-based online English teaching platform in colleges and universities. Through empirical research, teacher and student feedback and teaching effect data are collected to optimize the platform. The innovation is to propose optimization solutions based on various needs, and at the same time combine big data and artificial intelligence to achieve accurate analysis and personalized recommendations.

2 Overall architecture design of web-based online English teaching platform in colleges and universities

The online English teaching platform for colleges and universities designed in this study is built on the web platform. Its overall architecture can be seen in Figure 1.

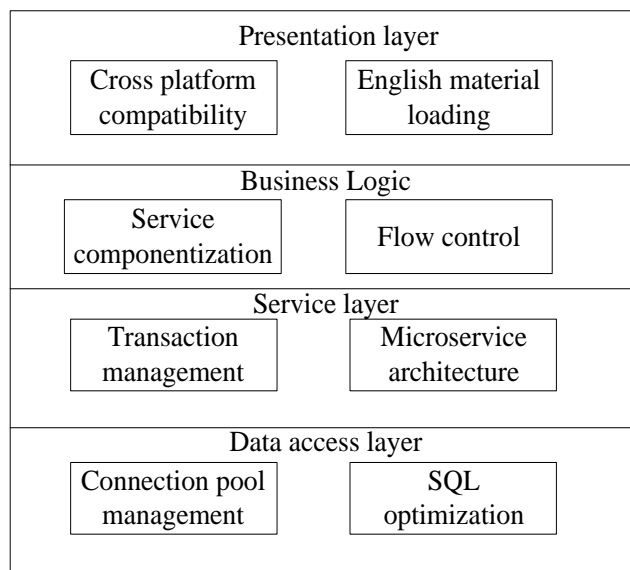


Figure 1: Overall architecture of web-based online English teaching platform in colleges and universities

The architecture is divided into presentation layer, business logic layer, data access layer, and service layer. The presentation layer uses web pages to collect user input and transmit it; the business logic layer is the core, and after processing, the feedback results are fed back to realize the teaching function; the data access layer interacts with the database to access data; the service layer uses relevant technologies to achieve system integration and improve flexibility.

3 Hardware Design of an Online English Teaching Platform for Universities

3.1 Web Application Server

The web is a system accessible through the Internet, built from a vast array of interconnected hypertext files [5, 6]. The detailed structure of a web application server is shown in Table 1. Its components precisely locate various resources, which are then transmitted to users via HTTP (Hypertext Transfer Protocol). Users simply click a link to access the desired resource [7, 8].

Table 1: Schematic Diagram of Configuration Tool Relationships

Serial Number	Tool Name	Main Functions
1	Netbox	Simplifies Web server setup, supports HTTP/HTTPS protocols, publishes static/dynamic websites, and provides basic management functions such as log recording, access control, and error handling.
2	Apache	A stable and reliable Web server software that supports cross-platform operation and is highly extensible.
3	Nginx	A high-performance Web server that supports reverse proxy, load balancing, HTTP caching, and TLS termination.
4	Tomcat	A Java application server that supports Servlet containers and JSP pages.
5	IIS (Internet Information Services)	Integrated into Windows Server, supports dynamic languages such as ASP.NET and PHP.
6	Lighttpd	A lightweight Web server that emphasizes low memory usage and high concurrency performance.
7	Caddy	A modern Web server with built-in HTTPS support and simple configuration.

The web application server in the online English teaching platform designed in this paper is a Dell PowerEdge R750xs model, equipped with 512GB DDR4 ECC memory and 8×1.92TB NVMe SSD (using RAID 10 mode), so that it can be used to run the backend of the teaching platform and ensure the stable operation of functions such as user authentication and course management modules.

3.2 Processor

This article uses the Core i5-13600K/KF processor as the core hardware component, and its architecture is shown in Figure 2. This processor adopts a heterogeneous core design, with performance cores and energy efficiency cores coordinated for scheduling, which can not only respond quickly under peak loads, but also reduce power consumption under light loads. Its integrated memory controller and PCIe channel effectively reduce data exchange latency, meeting the platform's dual requirements for real-time interaction and batch data processing.

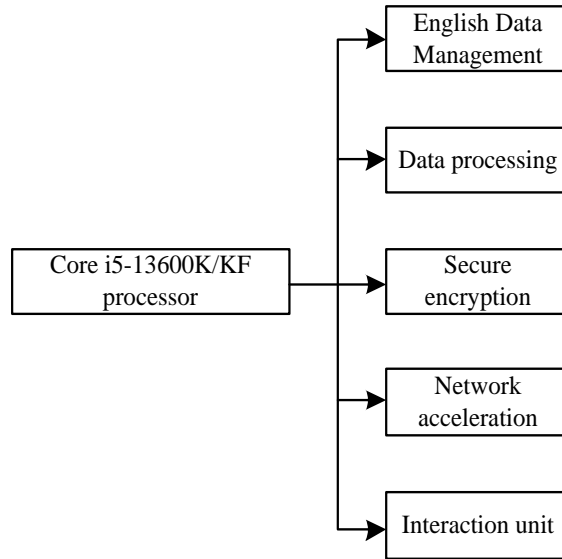


Figure 2: Processor Architecture

Figure 2 shows the functional module division of the processor. Among them, the English data management module is responsible for classifying and organizing the student learning behavior data collected by the platform; The data processing unit is responsible for intermediate result caching and computation during Z-score standardization and K-means clustering processes; The secure encryption module ensures the confidentiality of user authentication information and transmission content; Optimize the parsing and response queue scheduling of HTTP requests through the network acceleration module; The interaction unit manages the instruction conversion between the front-end interface and the back-end service. This customized module partitioning method based on business requirements enables processors to perform hardware level acceleration for specific tasks in online English teaching scenarios, reducing redundant scheduling overhead at the software layer.

3.3 Video Server

Figure 3 shows the architecture of the video server selected for this platform design. Regarding the HD camera, the Logitech Brio 4K Pro webcam was chosen. It features 4K resolution, HDR, 5x digital zoom, and Windows Hello facial recognition. It primarily captures HD video from the teacher's end [9, 10].

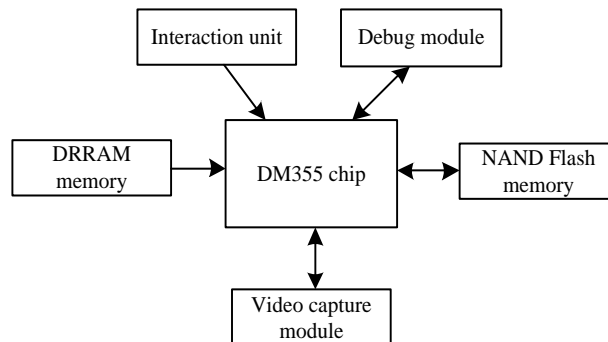


Figure 3: Video Server Structure

The student terminal is equipped with an Intel Core i7-1360P processor, 32GB of LPDDR5 memory, and a 2.8K OLED touch screen. Its purpose is to enable students to access the web platform and participate in real-time interactions.

4 Software design for the Online English teaching platform in colleges and universities

4.1 Setting Up the database for the Online English teaching platform in colleges and universities

The database for the online English teaching platform in colleges and universities has roles such as students, teachers, and administrators. Students register and log in to store their personal information to help teachers provide targeted instruction; teacher information, including teaching subjects, facilitates course selection; administrators manage all user information and have the authority to add, delete, modify, and query. The platform also needs to manage course resources and record learning processes [11, 12].

When setting up the database for the online English teaching platform in colleges and universities, the first step is to begin database design based on the requirements analysis and architecture [13, 14]. This process requires in-depth exploration of the complex relationships between entities and attributes, and between entities. Based on the above, the database settings are shown in Table 2.

Table 2: Database Parameters

Column Name	Data Type	Description
STUDENT_ID	varchar(20)	Student ID, uniquely identifying each student
STUDENT_NAME	varchar(50)	Student's name
GRADE	int	The grade the student is in
CLASS	varchar(20)	The class the student belongs to
TEACHER_ID	varchar(20)	The ID of the teaching instructor, linked to the teacher table
COURSE_ID	varchar(20)	The course ID, linked to the course table
LEARN_PROGRESS	int	Learning progress (expressed as a percentage)
LAST_LOGIN_TIME	datetime	The time of the student's last login to the platform
TEST_SCORE	decimal(5, 2)	Test score, accurate to two decimal places
CERTIFICATE_STATUS	varchar(10)	Certificate acquisition status (e.g., "Not Acquired", "Acquired")

The database design must be equipped with appropriate access control and permission management mechanisms to ensure that data security and integrity are not compromised [15, 16]. To ensure the security, reliability, and efficient access of online English teaching data, the university online English teaching platform database is configured based on the above parameters.

4.2 Personalized English teaching recommendations

In the field of personalized English teaching recommendations, big data analysis can comprehensively collect student information on the learning platform. Teachers can use this to

specifically adjust teaching priorities and difficulties, improving teaching accuracy and effectiveness.

This paper uses K-means clustering as the core algorithm to carry out recommendation research. K-means clustering [17, 18] can naturally group students based on feature similarity without the need for pre-set categories, thereby providing common recommendations for students in the same group. This method has moderate computational complexity and can adapt to the scale of hundreds of students involved in this study. The clustering results are easy to interpret, making it convenient for teachers to adjust their teaching focus and resource allocation accordingly.

The value range of each feature in the original online English teaching dataset may vary greatly, and all features need to be Z-score standardized. The Z-score standardization calculation method refers to formula (1):

$$z_{ij} = \frac{x_{ij} - \mu_j}{\sigma_j} \quad (1)$$

where, μ_j represents the mean of the j -th feature; σ_j represents the standard deviation of the j feature. This processing transforms the original data into a new distribution with a mean of 0 and a standard deviation of 1, making all features comparable [19].

The core algorithm of the K-means algorithm for personalized English teaching recommendation, the operation effect depends on the initial center selection. Randomly select k points from n student data points as the initial cluster centers $c_1^{(0)}, c_2^{(0)}, \dots, c_k^{(0)}$, where the superscript represents the number of initial iterations. The Euclidean distance $d(z_i, c_l)$ for each student data point $z_i = (z_{i1}, z_{i2}, \dots, z_{im})$, $c_l = (c_{l1}, c_{l2}, \dots, c_{lm})$ ($l = 1, 2, \dots, k$) is:

$$d(z_i, c_l) = \sqrt{\sum_{j=1}^m (z_{ij} - c_{lj})^2} \quad (2)$$

Then transfer the student data points z_i allocate to the nearest cluster C_l , namely:

$$label(z_i) = \arg \min_{1 \leq l \leq k} \{d(z_i, c_l)\} \quad (3)$$

where, $label(z_i)$ represents the cluster label to which it belongs for student data points z_i . For each cluster C_l , its center $c_l^{(t+1)}$ is recalculated. (t is the current iteration number), that is, the mean of all data points within the cluster is calculated:

$$c_{lj}^{(t+1)} = \frac{1}{|C_l|} \sum_{z_i \in C_l} z_{ij} \quad (4)$$

where, $|C_l|$ represents the number of data points in the clusters C_l . When the cluster center no longer changes or reaches the preset maximum number of iterations T , the algorithm terminates. Namely:

$$\|c_l^{(t+1)} - c_l^{(t)}\| \leq \alpha \quad (5)$$

where, α is a pre-set threshold [20]. After completing data preprocessing and K-means clustering, a feature vector is constructed for each student to achieve personalized recommendations for online English teaching.

Considering that student learning is a dynamic process, student learning data is collected regularly (e.g., weekly or monthly) and K-means clustering and personalized recommendations are performed again.

5 Platform application effectiveness analysis

5.1 Application preparation

A test framework simulating a real-world environment was built. The pre-set test environment parameters for this experiment are shown in Table 3.

Table 3: Test Environment Parameters

Serial Number	Item Name	Parameters
1	Server	Dell PowerEdge R740
2	Operating System	Windows Server 2022
3	Database Management System	Microsoft SQL Server 2019 / MySQL 8.0
4	web Server/Middleware	Apache Tomcat 9.0
5	Development Tool	IntelliJ IDEA Ultimate
6	Front-End Framework	Vue.js 3.0 / React 17
7	Back-End Framework	Spring Boot 2.5 / Django 3.2
8	Load Testing Tool	Apache JMeter 5.4
9	Code Quality Tool	SonarQube 9.0
10	Browser Compatibility	Chrome 90+, Firefox 88+, Safari 14+
11	Security Scanning Tool	OWASP ZAP 2.10 / Nessus 10.0

To ensure the credibility and persuasiveness of the experimental results, 800 students (all volunteers) from a comprehensive university were selected as test subjects. They came from a variety of disciplines. The grade distribution was evenly distributed, with 200 students in each grade, maximizing coverage of students at different learning stages and knowledge bases.

The student user interface operation flow is shown in Figure 4. After accurately entering their username and password, students enter the work interface. Users can query information related to English courses. The system features a message board where students can ask questions to teachers and view the progress and content of responses in real time.

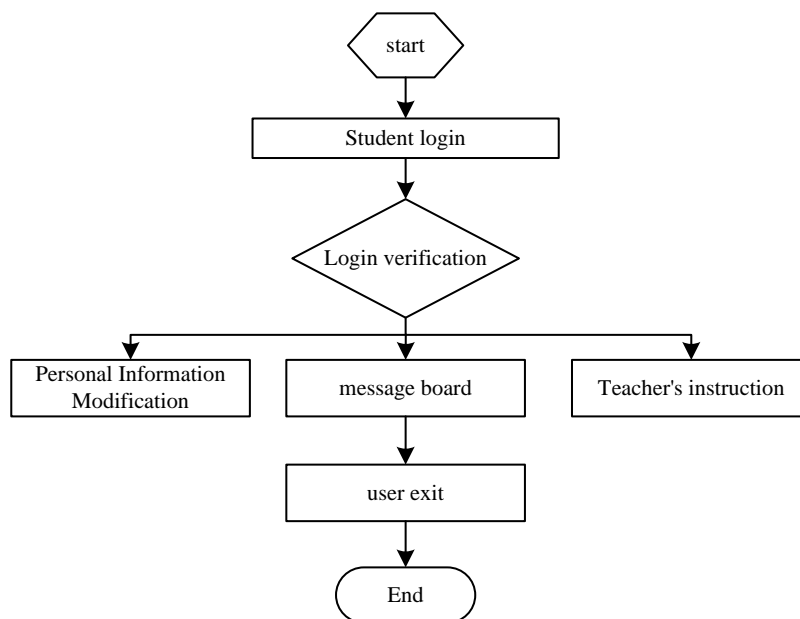


Figure 4: Student User Interface Operation Flowchart

After the test system was established and the test sample was determined, the platform's core teaching functions were tested to ensure that the platform could strictly implement various teaching functions according to the pre-planned requirements.

5.2 Application results

During the one month testing phase, all the basic functions preset by the platform were able to be executed stably without any significant deviations. Therefore, further testing will be conducted on the platform from multiple dimensions, including platform performance, teaching effectiveness, learner performance, and interface response latency, to systematically evaluate it.

5.2.1 Platform performance test

This test conducted a performance test of this platform, using a professional load testing tool (Apache JMeter) to simulate a multi-user concurrent access scenario. The test results are shown in Table 4.

Table 4: Platform Performance Test

Number of Students	Page Load Time (s)	Memory Usage Rate (%)	CPU Utilization Rate (%)	Success Rate (%)
100	0.8	22	28	99.8
200	0.9	25	32	99.6
300	1.0	30	38	99.4
400	1.1	35	45	99.2
500	1.3	40	52	99.0
600	1.4	45	58	98.8
700	1.6	50	65	98.5
800	1.8	55	72	98.2

Table 4 shows that as the number of concurrent students increases from 100 to 800, the page loading time gradually climbs from 0.8 seconds to 1.8 seconds, the memory utilization rate increases from 22% to 55%, the CPU utilization rate also increases from 28% to 72%, and the request success rate slowly decreases from 99.8% to 98.2%. This trend indicates that the platform has low resource utilization and rapid response during the light load phase. As the number of concurrent users increases, the system resource consumption shows an approximately linear growth. However, even in the high load scenario where 800 people are online simultaneously, the page loading time is still controlled within 1.8 seconds, and the success rate remains above 98%, indicating that the platform has good concurrent processing capabilities and stability. Further analysis revealed that there was no sudden increase in memory and CPU utilization or drastic fluctuations caused by resource contention, reflecting that hardware selection and software architecture were relatively reasonable in resource scheduling. Although the success rate slightly decreases with the increase of load, it is still at a high level, which may be related to the timeout or retransmission of a few requests under extreme concurrency. Overall, the platform is capable of supporting large-scale online English teaching scenarios with robust performance, providing data support for further promotion.

5.2.2 Satisfaction with platform teaching effectiveness

In order to further evaluate the satisfaction of the platform's teaching effectiveness, the experiment used a questionnaire survey to examine the level of user recognition of the platform's teaching effectiveness. The questionnaire content is divided into dimensions such as course content arrangement, teaching method design, teacher-student interaction process, and learning resource supply, to collect users' subjective evaluations of the platform's teaching effectiveness. After sorting, the obtained data is shown in Figure 5.

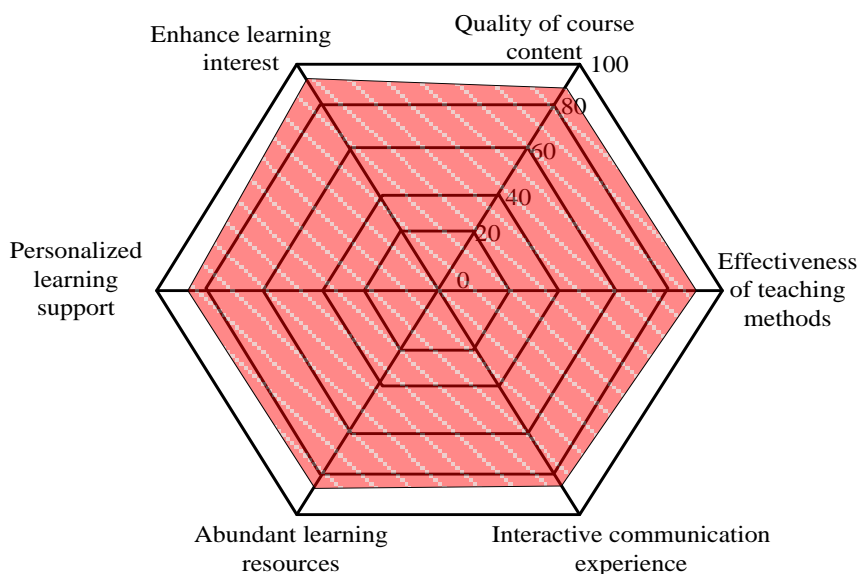


Figure 5: Satisfaction with Platform Teaching Effectiveness

A survey on teaching satisfaction with the web-based online English teaching platform for universities reveals a relatively positive overall performance based on the collected data across six indicators. The student approval rate for course content quality is 89.0%, and the approval rate for teaching method effectiveness is 91.5%, indicating that it can improve students' knowledge absorption efficiency. The approval rate for the interactive communication experience is 87.0%, indicating that the convenience and variety of learning

resources could be improved. The approval rate for the richness of learning resources is 88.5%, indicating that students expect greater diversity. The recognition rate of personalized learning support is 89.5%, which can help learning. The recognition rate of improving learning interest is the highest, reaching 92.0%.

Overall, the platform's teaching effectiveness is excellent, with students highly recognized for most indicators. It has achieved outstanding results in increasing interest and emphasizing the effectiveness of teaching methods. It can effectively improve English teaching outcomes, has application value, and is subject to future optimization and improvement.

5.2.3 Student English learning outcomes

To evaluate student English learning outcomes, a pre-test and post-test comparison method was used. Students' initial English proficiency was first assessed, and then re-tested after a period of platform learning. The scores were compared to assess progress. A comprehensive assessment was also conducted based on daily performance and homework. The results are shown in Figure 6.

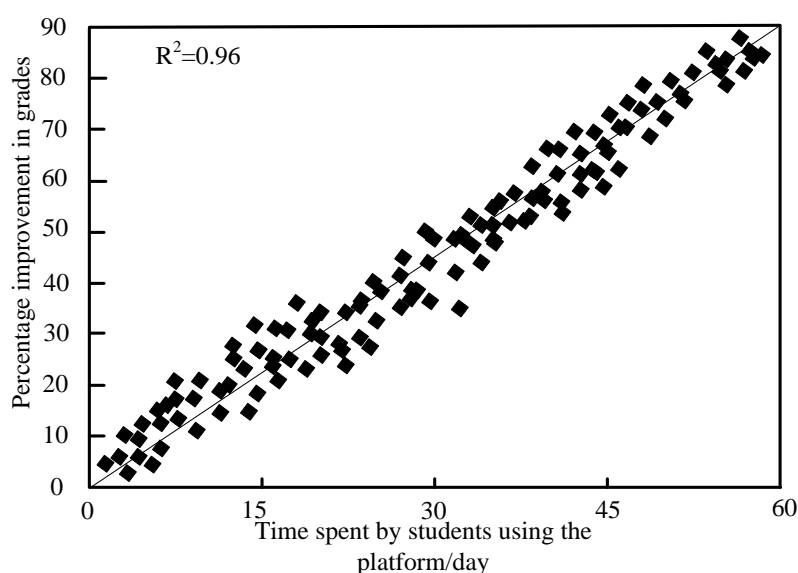


Figure 6: Scatter plot of learning effect

As shown in Figure 6, the time students use the platform is positively correlated with the percentage of improvement in learning performance, with an R^2 of about 0.96, and the scatter plot shows a clear upward trend. As the time students use increases, the percentage of improvement in performance increases steadily, indicating that the platform has a positive role in promoting English learning, can provide resources and personalized paths to improve efficiency, and is worthy of promotion and application.

5.2.4 Interface response speed

This paper uses professional performance monitoring tools to test the interface response speed of the platform. Taking the dynamic frame number as an indicator, in the test, the response of the platform under different operations is evaluated by observing the change of the frame number. The proposed method was compared with the platform response speed in references [1-3], and the test results are shown in Figure 7. The test results are shown in Figure 7.

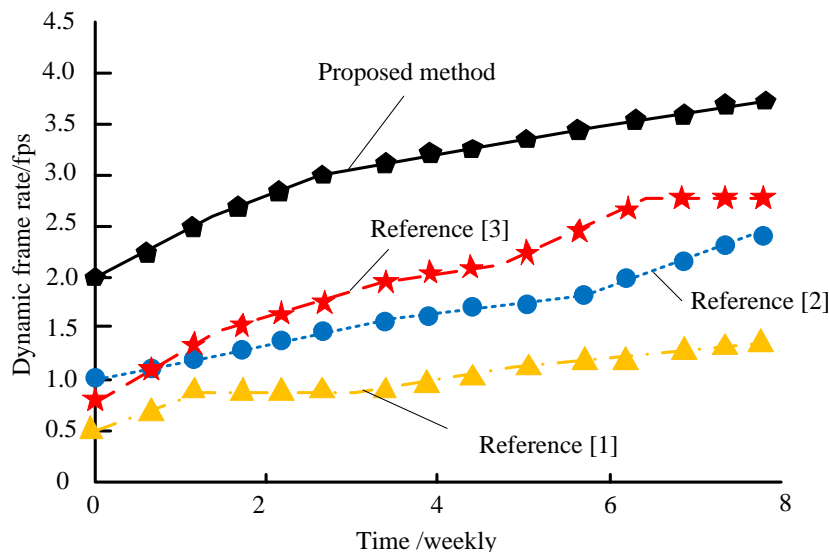


Figure 7: Dynamic frame number change

Figure 7 shows the dynamic frame rate changes of the proposed method and the reference method at different testing times. From the figure, it can be seen that the dynamic frame rate of the proposed method remains at a high level, from 2.0 fps in week 0 to nearly 3.0 fps in week 3. The frame rate of method in reference [1] has also increased, but the overall level is lower than that of the proposed method; The frame rate of method in reference [2] fluctuates greatly and the improvement is limited; The frame rate of method in reference [3] has remained at a low level, with almost no significant improvement.

By comparing the above data, it can be seen that the proposed method can continuously maintain and improve the dynamic frame rate, providing users with a smoother and more efficient online English learning experience, and has significant advantages and application value.

6 Conclusion

This study focuses on the construction and validation of a web-based online English teaching platform for universities, including hardware selection, database design, and personalized recommendation algorithms. In the research process, this article introduces K-means clustering into English teaching scenarios and combines Z-score standardization to process student learning behavior data, achieving personalized resource push without relying on preset labels. At the hardware level, this study addresses the high concurrency and real-time interaction requirements of online teaching by selecting heterogeneous core processors and high-performance storage architectures. This enables the platform to maintain a page loading time of 1.8 seconds and a request success rate of over 98% even when 800 people are online simultaneously.

The empirical results indicate that the platform performs well in enhancing learning interest, teaching method effectiveness, and smooth interface response. Of course, there is still room for improvement in this study. The platform is limited by the experimental period and sample range, and the current clustering update frequency is once a week. Real time dynamic adjustment has not yet been achieved. Moreover, although the students participating in the test cover different grades, it is limited to one university, and the extrapolation of the conclusions needs to be verified by more universities. In the subsequent work, incremental clustering or

deep embedded representation learning methods will be introduced to enable the recommendation system to respond in real-time to changes in students' learning trajectories. At the same time, the experimental scope will be expanded to explore integration paths with technologies such as virtual reality and natural language processing, further improving the platform's immersion and interactive intelligence level.

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