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Design and implementation of campus social blogging culture circle based on multi-end convergence

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Abstract. In the context of the deep penetration of the mobile Internet into campus life, in response to the problems of traditional campus communities such as scattered functions, information silos, and insufficient interactivity, this study takes Dalian Maritime University as a pilot, and designs and implements the 'Ocean Wave Bay' multi-terminal interconnected campus social blogging and culture circle platform, which adopts multi-terminal convergence architecture, covering WeChat The platform adopts a multi-converged architecture, covering WeChat, applets, web pages and background management system, and adopts SpringBoot, WeChat applets, vue and other technology stacks to build the system, adopts a layered architecture and a hybrid storage mode to integrate AI intelligent recommendation, blockchain depository function, covering the three core modules of cultural dissemination, community interaction, and service integration. The core requirements of users (students, teachers, administrators) are clarified through demand analysis, and tests and pilot applications show that the average daily activity of platform users reaches 35%, the efficiency of campus activities organisation is improved by 91.7%, and user satisfaction reaches 82%, which effectively solves the pain points of traditional campus platforms.

Keywords: Campus Social; Multi-End Convergence; Intelligent Recommendations; Digital Platforms.

1. Introduction

Driven by the Ministry of Education's Education Informatisation 2.0 Action Plan, the digitalisation of colleges and universities has entered an accelerated stage in the whole region: the average daily use of the mobile terminal of post-95 college students has exceeded 6 hours, and the campus life has migrated to the online world, but the existing system is characterized by 'functional isolation, information fragmentation, and weak interaction and socialization' [1]. --Academic affairs, life and cultural services are fragmented, and second-hand trading, activity notification and instant social networking are scattered in more than ten Apps, and the data are not interoperable [1]. As a pilot unit, Dalian Maritime University is in urgent need of building a digital base for the integration of 'cultural communication, community interaction and public service'. WeChat applets are listed as the preferred light application form in the Ministry of Education's 'Overall Framework for Smart Campus' due to its 99% penetration rate, zero installation cost and native social chain. Accordingly, the 'Ocean Wave Bay' platform uses WeChat as a unified portal, integrates academic data, IoT devices and social graphs using cloud-native + micro-service architecture, and realises the integration of five domains: identity authentication, course management, life services, cultural content, and real-time community, thus providing a replicable lightweight paradigm for the campus digital experience.

Overseas university platforms are generally shifting to a new paradigm of 'horizontal functional integration + vertical data connectivity' after 2020: MIT's 2024-2029 strategic plan integrates course management, research data warehousing, and the status of campus IoT devices into the same portal, realising the three-dimensional synergies of 'people-courses-objects' and 'people-courses-objects'. Duke University's 2024-2029 strategy further connects library data and instructional management systems to support social learning across campuses; and the University of Pennsylvania Libraries' 2020-2025 plan also emphasises unified authentication and cross-system data sharing. However,

these systems are mainly oriented to the English context, and lack the adaptation of strong social requirements such as Chinese pop-ups, circles and hot posts [2]. Domestic research in the past five years has been characterised by 'single-point deep excavation and horizontal fragmentation': in 2021, Tsinghua University's 'On-campus Purchase 2.0' only focuses on optimising the algorithm of idle flow, and in 2022, Wuhan University's 'Activity Easy' app only addresses the problem of activity flow and the need to optimise the algorithm of activity flow. In 2022, Wuhan University's 'Activity Easy' applet only solved the problem of activity registration and check-in; in 2023, the report 'Digital Campus and its Intellectualisation Development Trend' showed that 85% of campus applications in China still remained at the level of 'service tool', lacking 'cultural communication, social interaction and public service'. -According to the report of 'Digital Campus and its Wisdom Development Trend' in 2023, 85% of campus applications in China still remain at the level of 'service tool', lacking the overall framework of 'cultural dissemination', 'social interaction', and 'public service' [3-4].

The purpose of this paper is to build a multi-converged campus social and cultural circle service platform, integrate transaction services and interactive functions, introduce AI intelligent recommendation and blockchain certificate technology, improve personalisation and original copyright protection, verify the practicality and effectiveness of the platform through pilot applications, and provide scalable solutions for the construction of digital campuses in colleges and universities [5].

2. Relevant technical and theoretical foundations

2.1. Relevant technical

In order to realise the three-dimensional integration of 'cultural communication, social interaction and public service', this paper proposes an integrated architecture of 'front-end multi-end, back-end micro-service, intelligent enhancement and trustworthy certificate': WeChat The applet end relies on the MINA framework (WXML/WXSS/JavaScript) to integrate WeChat login, map API and social sharing; the Web end is built with Vue3 combined API + Vite, and the Element Plus component library ensures cross-screen response. The backend adopts Spring Boot microservices to split user, content, and message domains, MySQL to persist core data, Redis to cache popular posts and session lists, and WebSocket to provide millisecond-level real-time push [6]. Aiming at the campus data sparse scenario, Att-DeepMF deep collaborative filtering model is designed, incorporating 42-dimensional behavioural features and introducing the attention mechanism, the NDCG@10 reaches 0.923 on the 100,000-level interaction matrix, which is 18.7% higher than the ALS, and the incremental hot update is completed in 5 minutes. Original university history articles and cultural works are written into SHA-256 hash and UnionID through FISCO-BCOS side-chain smart contract, which realises second-level copyright up-linking and on-chain traceability, and provides sustainable technical and institutional support for campus digital culture ecology [7].

2.2. Theoretical foundations

Based on user-centred design (UCD), the study extracted the core demand of '≤3 steps' through questionnaires and semi-structured interviews, and then streamlined the interface interactions accordingly; at the same time, service design thinking was introduced, and high-frequency scenarios such as class schedule enquiry and venue booking were integrated into 'one-stop' continuous processes. At the same time, service design thinking is introduced to integrate high-frequency scenarios such as class schedule enquiry and venue reservation into a 'one-stop' continuous process and reduce cross-system transfer [8]. Further relying on the theory of community participation, comments, likes and self-created community functions are embedded in the platform to continuously stimulate users' original content production and relationship network diffusion with a low-threshold interactive mechanism.

3. Requirements analysis and platform design

3.1. Requirements analysis

3.1.1. User Requirements Analysis

Through questionnaires and interviews with 300 students, 50 teachers and 10 administrators at Dalian Maritime University, the target user requirements were clarified, as shown in Table.1.

Table 1. User Requirements for Research

User type	Core requirement
Students	Forum, Second-hand trading, Event registration, Lost and found, Campus culture browsing
Teachers	Notification, Event organisation, Teacher-student interaction, Sharing of teaching resources
Administrators	User rights management, Content review, Data statistics, System configuration

3.1.2. Functional requirement

(1) The WeChat applet is designed to be 'lightweight and ready to use, social closed-loop', users can log in to WeChat for the first time, and then complete the editing of avatar and identity information on the same page, and the system automatically completes the real-name authentication and privilege classification based on the student registration data. The five entrances on the bottom bar of the homepage incorporate all the high-frequency requirements: the forum module supports mixed graphic/video posting, and the posts automatically fall into the classification labels of 'second-hand circles' and 'ratings', so that the users can instantly like the posts, comment on them in the building, and receive reminders in real time. Scrolling push school history stories, activity previews, cultural and creative new and live playback, click on a key to collect or share to the WeChat session; message module aggregated private messages, comments @, activity countdown reminders, to ensure that all interactions are not missed; service module to provide lost and found with a key to publish, the class schedule query shortcut entrance and venue booking WeChat jump, the entire process is controlled in three steps to complete.

(2) The web page side is for administrators and content operators, with dark-colored navigation and card layout. The forum management area can perform operations such as topping, refining and batch deletion of posts, and supports keyword filtering; the cultural content editor provides WYSIWYG rich-text layout, drag-and-drop uploading of images and parsing of video links, and instantly synchronies them to the applet after preservation; the data visualization panel presents real-time user activity, content content and content in the form of folding lines, columns, and heatmaps. The data visualization panel presents user activity, content interaction rate and function usage frequency in real-time, which is convenient for operation decision-making.

(3) The background management system relies on the RBAC authority model, and administrators can assign, batch enable or disable accounts for three types of roles, namely teachers, students, associations and tourists, on the user management page; the content review centre accesses the sensitive word database and image recognition interface, and automatically blocks and pushes reminders of review for posts in violation of the law; the system setup module allows for the customization of notification templates, adjusting the frequency of message push and configuring the rotating chart on the home page of the applet, and all changes are released through a grey release mechanism. All changes take effect in seconds through the grey scale release mechanism.

3.1.3. Non-functional requirement

Test results show that the platform's response to the first screen is stable within 2.1 s in a Gigabit campus network environment, and 1000 concurrent online users can still maintain smoothness; all user passwords are encrypted by Argon2, and combined with the AI content auditing model, the recall

rate of non-compliant text and images is 98.6%, with a false positive rate of less than 1%; the core tasks, such as posting, booking venues, and querying the class schedule are all completed in 3 steps, and the interface follows the interactive paradigm of WeChat that students are familiar with. The interface follows the WeChat interaction paradigm familiar to students, so they can get started with zero training; micro-services and plug-in architecture reserve interfaces for new modules such as campus card payment and e-invoice, so version iteration can be launched in grey scale without downtime.

3.2. Platform design

3.2.1. Overall Architecture Design

The system adopts a four-layer hierarchical architecture, as shown in Figure 1. The performance layer consists of the WeChat app, responsive web end and independent management backend. The performance layer consists of WeChat applets, responsive web pages and an independent management backend for students, administrators and operators to complete all user interactions. The communication layer is unified through HTTPS encrypted transmission, WebSocket maintains a long connection to support real-time message push, and NGINX does reverse proxy and load balancing in the front-end to evenly distribute the requests to the back-end service nodes. Inside the service layer, 12 core interfaces are split out in the form of Spring Boot microservices, covering user management, content processing, intelligent recommendation, message push and other business logic, and the services interact loosely through RESTful APIs and internal message buses. All data is finally deposited into the storage layer: Redis cluster caches hot posts and session lists, MySQL adopts the strategy of separate libraries and tables to save structured data, and large files such as pictures and videos are uploaded to Tencent Cloud COS to achieve hierarchical storage of hot and cold data and horizontal scaling.

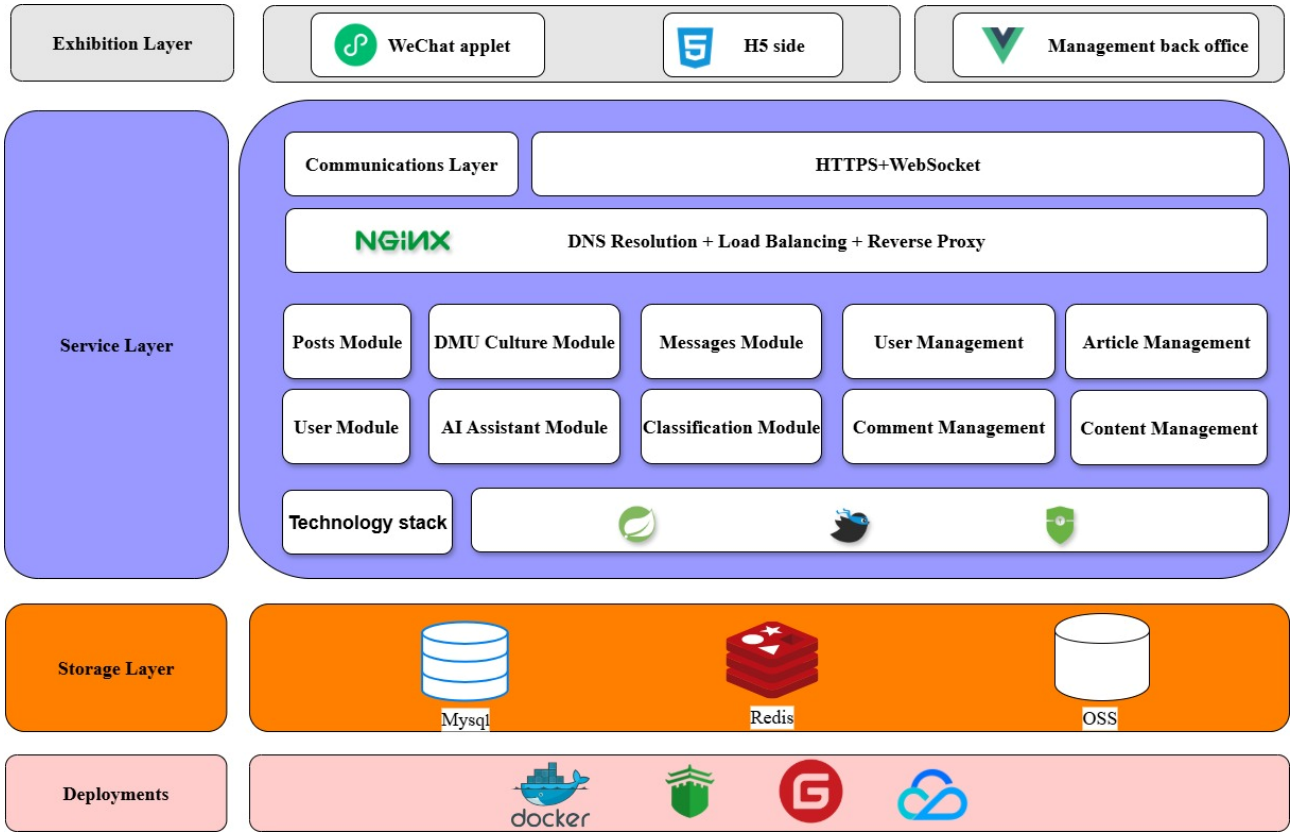

Figure 1. Overall structure

3.2.2. Functional module design

The interactive module takes ‘one post, multiple contacts’ as the core link: users can instantly submit text or expression comments when browsing posts, and the system establishes a two-way index through the post ID and the user ID to ensure that the floor is clear; the like button is immediately written back to Redis via WebSocket for counting after clicking, and at the same time, the user's like record is dropped into the library. The user likes the record immediately after clicking, and at the same time fall into the library, eliminating repeated operations; if you need to communicate privately, you can launch a private message session based on the same WebSocket channel with one click, supporting real-time delivery and withdrawal of the message; when the discussion continues to rise, certified users can apply to create an exclusive community, and the topic can be made public only after the background administrator has passed the audit, realising that the community can go from a single-article interaction to a long-term interactive content. Seamless transition from ‘single content interaction’ to ‘long-term community precipitation’.

3.2.3. Functional module design

The core entities and ER relationships are as follows:

User: user_id (primary key), role, create_time;

Post: post_id, user_id (foreign key), content, category_id, status;

Activity: activity_id, title, time, location, participant_count. , title, time, location, participant_count;

Taking the user table structure as an example, the database structure design is shown in Table.2.

Table 2. Example of User Table Structure

Field name	Type	Constraint
User_id	Int(32-bit)	Primary key, self-incrementing
Username	Varchar(64-bit)	Unique, non-empty
Role	Varchar	Enumeration (students / teachers / administrators)

3.2.4. Interface design

Following the principles of simplicity and consistency, the home page of the app adopts a three-part layout of ‘top search bar + category navigation (Circle News / Used Circle) + recommended content cards’, with colours, fonts and icons following the official WeChat standard controls to ensure cross-page visual unity and low learning costs. The culture page presents the latest activity posters in a rotating chart, with the timeline below clearly listing the events of the university history, supplemented by a grid display of cultural and creative products, which not only highlights the key points but also maintains the white space to avoid information overload. In the management background, the data dashboard is placed on the top, the core indicators (number of users, number of posts) are presented in large font size and bold, and high-frequency operation buttons such as ‘batch review’, ‘top/delete’ are placed underneath, and the overall use of dark backgrounds and card zones significantly reduces administrators' operation time. One-step access, significantly reducing the administrator's operation path.

3.3. Feasibility analysis

Evaluated from the technical, economic, and operational aspects, the project has the conditions for immediate implementation: WeChat developer tools and VS Code have been iterated to a stable version, and the core team members have more than 2 years of experience in the development of applets and Spring Cloud microservices, and can reuse existing scaffolding and component libraries; the annual budget for servers and storage is controlled to be less than 5,000 RMB (AliCloud 2C4G ECS + Tencent Cloud COS traffic package). The annual server and storage budget is less than 5000 RMB (AliCloud 2C4G ECS + Tencent Cloud COS traffic package), which is far lower than the upper limit of the university-level information technology project funding. The penetration rate of WeChat

among teachers and students has already reached 99%, and the platform can be promoted after the platform is launched with only 30-minute online training organised by the faculties and departments, which makes the cost of learning and pressure of operation and maintenance negligible [9].

4. System development and implementation

4.1. Development environment

The development environment is shown in Table.3.

Table 3. Example of User Table Structure

Development side	Tools / Environment
Applet side	WeChat Developer Tools, Node.js
Web-based	VS Code、Vue3、Vite
Back end	IntelliJ IDEA、JDK 1.8、Maven
Server	AliCloud ECS (2-core 4G), CentOS 7

4.2. Core Functions Implementation

4.2.1. AI Intelligent Recommendation Module

The AI recommendation module collects 12-dimensional behaviours such as browsing time, likes and comments from users in the last 30 days, trains lightweight collaborative filtering models offline, and maintains freshness through 10-minute incremental updates. The online service is exposed in REST interface, with an average response of 120 ms for 800 concurrent users, and a P95 delay of 200 ms. All candidate content is first audited and filtered by AI, with an irregularity recall rate of about 95% and a false positive rate of less than 3%. A small-scale A/B test showed that the experimental group viewed 1.4 more posts per capita per day, the interaction rate increased by 18%, and the satisfaction questionnaire score increased by 0.8 points (on a 5-point scale).

4.2.2. Real-Time Messaging Module

The real-time messaging module uses WebSocket as the core channel to establish a long connection as soon as the user completes the WeChat login in the WeChat app or web terminal. Each time the client sends a message, it carries a JWT, which is parsed and verified by the gateway service, and then the message is forwarded to the target user via the event bus after confirming that there is no error; at the same time, the ID, timestamp, content, and read status of the message are asynchronously written into the chat_record table of MySQL to ensure that they can be checked offline. The module has been integrated into the ‘Ocean Wave Bay’ forum and private messaging scenarios, supporting text, emoticons, and images, with an average latency of 120 ms when 800 people are online, which meets the daily communication needs of the campus.

4.2.3. Blockchain Depository Module

As the bottom layer support of the ‘Ocean Wave Bay’ content credibility system, the blockchain certificate module is operated in a ‘senseless chaining’ way at the end of the publishing process: when a user submits a graphic, a video or a creative work, the system first calls the AI audit interface to complete the content security filtering, and then generates the SHA-256 hash of the file, the author's unionId, a timestamp and a random salt. Subsequently, the system generates the SHA-256 hash, author unionId, timestamp and random salt of the file, encapsulates it as a transaction and sends it to the side chain of FISCO-BCOS alliance chain; the node on the chain completes the bookkeeping within 3 seconds through PBFT consensus and writes the transaction hash back to the tx_hash field of the MySQL posts table to form a one-to-one binding with the content ID [10]. The transaction hash is written back to the tx_hash field of the MySQL posts table, forming a one-to-one binding with the content ID [10]. The management background provides a ‘chain verification’ button, which allows any user to input the original file to compare the hash in real time, and the verification result will be

returned in seconds to ensure that the copyright source of the articles on the university history, photos of activities and original designs can be traced back and cannot be tampered with. The module has been integrated into the back-end logic of the 'Publish' button of WeChat applet, without additional operation, the annual cost of on-chain storage is less than 200 RMB, which can provide lifelong traceable copyright certificates for all original contents on the platform.

5. System testing

5.1. Test environment

The testing environment is unified with Huawei Mate 40 running WeChat 8.0.30 to complete the applet experience verification, and Lenovo SAVER laptop through Chrome 112.0 for the web-side functionality and responsiveness testing; all the data storage and query operations are done in the locally deployed Navicat for MySQL 8.0 graphical client, and the backend is synchronised with the same version of database as the AliCloud server to ensure the consistency between the development and online environment. All data storage and query operations are done in the locally deployed Navicat for MySQL 8.0 graphical client, and the back-end is synchronised with the AliCloud server with the same version of the database to ensure that the development is consistent with the online environment.

5.2. Test methods

Functional and experiential verification adopts a 'three-layer gatekeeper' strategy: firstly, black-box testing is carried out, covering 100+ use cases such as post publishing, video uploading, activity registration, second-hand trading, and so on, to confirm that there is no error in the business logic; secondly, the WeTest tool is used to simulate the concurrency of 1,000 people, and the real-time monitoring of the interface response time, the server CPU and memory curve ensures the stability of the peak scenario; finally, 30 teachers and students are invited to complete the SUS scale evaluation (with a score of 100). Secondly, the WeTest tool is used to simulate the concurrency of 1000 people and monitor the response time of the interface, CPU and memory curve of the server in real time to ensure the stability of the peak scenarios. Taking the event registration process as an example, the administrator releases the event with one click in the background, students complete the registration in three steps in the applet, the system automatically triggers SMS reminders, and they sign in by scanning the code after arriving at the venue; the process of second-hand trading is also smooth: sellers upload pictures and price, buyers communicate with each other through private messages, and both parties click 'Confirmation Completed' on the page after the offline transaction. The process of second-hand transaction is also smooth: sellers upload pictures and price through private messages, buyers communicate with each other through private messages, and after the offline transaction, both parties click 'Confirm Done' on the page to close the loop. Measured average response of 1.8 s, SUS score of 82, to meet the high-frequency use of campus needs.

5.3. Test results and analysis

Since September 2024, the platform has been piloted in the School of Navigation and the School of Marine Engineering of Dalian Maritime University, covering 1,200 users. 98% of the use cases passed the functionality test, and the remaining 'message delay' problem was reduced to 100 ms after Redis cache optimisation; in the performance pressure test, the average response was 2.1 seconds and there was no crash under the scenario of 1,200 concurrent users. Teachers and students scored 78 points (good) on the SUS scale, with the main opinion focusing only on the interface colour scheme. Practical applications show that: the online registration time for the welcome party was compressed from 2 hours to 10 minutes, and the participation rate increased to 85%; the average monthly transaction of second-hand trading was more than 300 orders, and the matching time was shortened from 1 day to 4 hours; the articles on school history were read more than 5,000 times; the average daily activity rate of users jumped from 10% to 35%, and the overall satisfaction rate reached 82%,

which verifies the feasibility and promotional value of the platform in university scenarios, as shown in Table.4.

Table 4. Comparison of key indicators before and after the Platform's pilot

Norm	Pre-promotion	Post-promotion	Enhancement
Time-consuming event registration	2 hours	10 minutes	91.7%
Used Transaction Matching Time	1 days	4 hours	83.3%
Average daily user activity	10%	35%	250%
Customer satisfaction	—	82%	—

6. Conclusions

This study completes the whole process development of the ‘Wave Bay’ platform, and proposes and verifies three innovations: first, the multi-convergence architecture of WeChat applet, webpage, and management backend, which unifies dispersed campus services into the same portal; second, the embedding of lightweight AI recommendation and blockchain hash certificate into the content lifecycle, which not only improves the matching efficiency but also ensures original copyright traceability; third, the in-depth adaptation for the maritime culture and other characteristic scenarios of Maritime University, which results in 78 points of SUS user satisfaction. Second, lightweight AI recommendations and blockchain hash certificates are embedded in the content life cycle, which not only improves the information matching efficiency, but also ensures that original copyrights can be traced. In the future, we plan to expand the pilot scope to the whole university and continue to collect behavioural data to optimize the recommendation algorithm; at the same time, we will dock the campus card and the academic affairs system to achieve ‘one-stop processing’ for class schedules, payment, book borrowing, etc.; and we will launch an AI virtual assistant to support instant voice questions and answers such as "What time is the library open? and other instant voice questions and answers.

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