Design of Online Teaching System for Theory of Variable Order Fractional Gradient Descent Method

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Abstract. The functional modules of the online teaching system of healthy law theory are not perfect enough, and there are some limitations in practical application. Aiming at the problem of poor operation of online teaching system, this paper puts forward the theory of Variable Order Fractional step-down method, the design method of online teaching system, optimizes the system hardware structure, improves the operation performance of system hardware, and optimizes the function of system software. Combined with the theory of variable order fractional step-down method, the teaching management evaluation algorithm is realized. Finally, it is confirmed by experiments, The online teaching system of Variable Order Fractional gradient descent method theory has high practicability in the process of practical application, and fully meets the requirements of system design.

Keywords: Variable order fractional step · Online teaching · Teaching system

1 Introduction

At present, with the rapid development of modern educational technology, most colleges and universities begin to use network communication technology and multimedia technology to carry out teaching, and various teaching activities based on network environment are gradually carried out [1]. Compared with the traditional teaching mode, online teaching has great advantages in time, space and content. It not only provides rich teaching resources, but also provides a communication system between teachers and students. At the same time, it also improves students' learning enthusiasm and ensures the learning effect. At present, the network has penetrated into all aspects of social life and played a great role. In college teaching, Network online teaching system is a supplement to the traditional "face-to-face teaching", which expands the space and time of traditional teaching, prolongs its teaching process and improves the teaching effect [2]. The network online teaching system also makes full use of the teaching resources in the cyberspace, greatly meets the needs of students and effectively serves the teaching. At the same time, it can also use big data, big algorithms and other technologies to provide students with personalized learning content and learning forms, so that students

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can experience a new teaching mode and provide students with a more free way of autonomous learning.

As teachers and students increasingly use the Internet for teaching, the traditional concept of office hours is gradually disappearing. Teachers in schools use online teaching systems to assign homework to students. Many students find it more convenient and free to keep in touch with their teachers in this way. By asking questions without face-to-face contact, students feel more at ease. Students now live in a world of computer networks. In fact, students don't even need to set foot in university to complete the classroom knowledge, TV or distance learning has been used in continuing education and remote areas for more than 10 years. With the progress of technology and the development of Internet, online assisted teaching will become the mainstream of development. Therefore, the online teaching system based on the theory of step-down method of variable grade is designed. The system has better performance and can better serve teachers and students.

2 Online Teaching System of Variable Order Fractional Gradient Descent Method Theory

2.1 System Hardware Configuration

The system design is mainly to realize online teaching. The system uses WebService under dotnet to provide system interface and provide application interface for system integration and data integration in Colleges and universities. The front-end implementation of the system requires generous and beautiful interface, friendly and convenient user operation. The main objectives of the system design are as follows: to meet the functional requirements of the online teaching system [3]. Students can easily enter the front end of the system and carry out information browsing, online examination, online communication, homework submission and other functions; The function of system design should be simple, easy to use and practical [4]. The excessively complex system will bring users into a misunderstanding. The goal of this system design is to adopt the current general online teaching process to realize the system operation, which is easy to use, simple and powerful; System design should pay attention to the principles of system scalability and reusability; Based on the functional requirements of the system design, the system network deployment structure is optimized, as shown in Fig. 1.

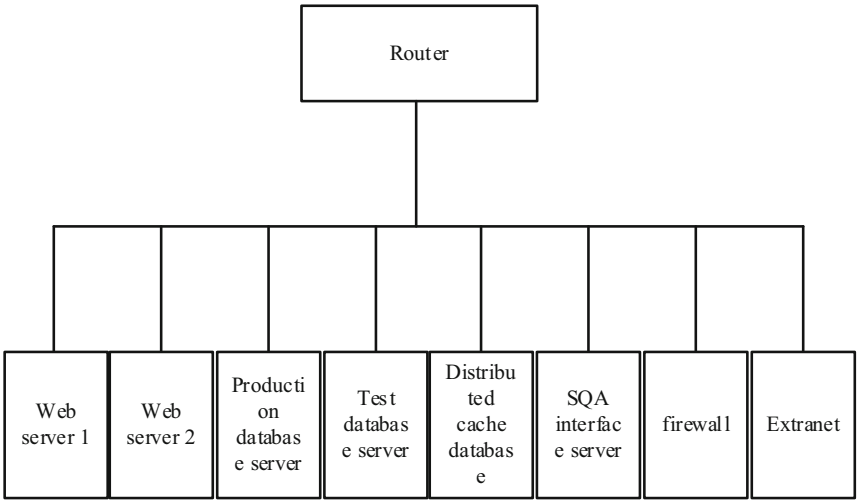

Fig. 1. System network deployment structure

In the process of building the system structure, the application mainly includes server-side and client-side. Therefore, the following types of development tools need to be applied. The development environment is usually based on Windows 7, and the

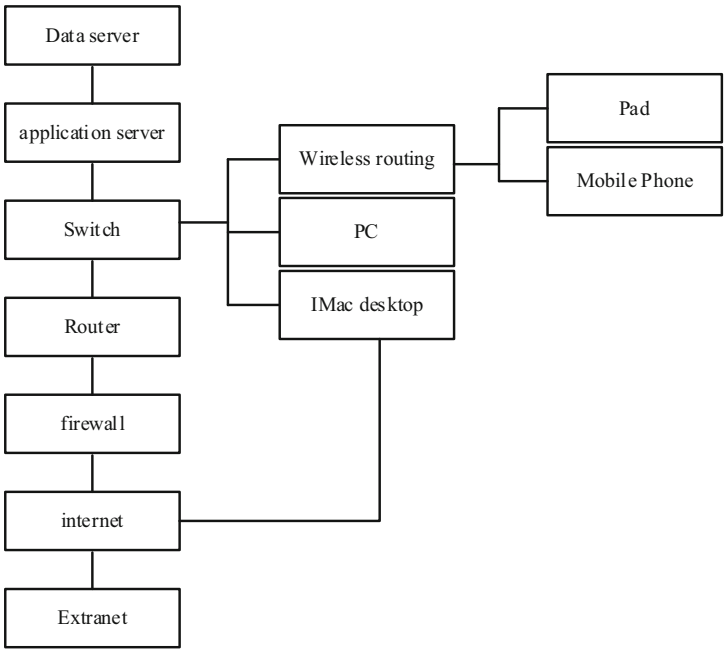

Fig. 2. System hardware structure setting

version uses 64 bit DK16. The mobile client mainly uses the Android system [5]. The development server mainly applies the 12ef development version, and the database uses the sqlserver2010 version. In the specific development process, the specified server is not proposed, but the corresponding server system is built through the laptop. In this way, the running environment is simulated [6]. At the same time, the wireless routing is simulated with the help of the shared network and provided to the mobile terminal to realize the access to the network. With the help of this local area network form, the server is simulated by laptop, and the network teaching system is developed and debugged. The system adopts B/s network architecture, and the network architecture diagram is shown in Fig. 2.

The online teaching system is developed with B/S structure (B/S structure, i.e. browser/server mode). It is a development mode of web application. Most clients use the browser as the main application software for browsing web pages. By using the existing server software, the client development is simplified, so that the core of the system function realization is concentrated on the server system. Users log in to the system through the Internet and use personal computers, mobile phones and other terminals to access the system interface for data interaction [7]. In the process of information exchange, the user uses the browser to connect with the server background, and the data is encapsulated into data packets of different protocols. The client browser and the server background interact with each other through different data packets. In the process of data exchange between the client and the server, if there are information security requirements, You need to use a network firewall to ensure data transmission and data security of the user's computer.

2.2 System Software Function Structure

Through the research on the key points and difficulties in the construction of online education information resource system based on campus network, the functional design of the system aims to meet the requirements of online teaching, and can fully interact, have knowledge base construction and feedback support. There are several modules such as course information management, audio and video management, online testing, interactive Q & A and resource center discussed in the above chapter, The composition is shown in Fig. 3.

Teaching resources are an important part of the online teaching system. Students can learn according to the teaching resources released by teachers. The materials are rich, which makes students' learning vision broader. The main purpose of the resource center is to break the restrictions of time and space, realize resource sharing, and enable teachers and students to broaden their horizons and learn more. Users can learn from each other and make progress. Teachers upload courseware resources of relevant courses. Student users browse courseware resources of courses through the main page of the system for downloading and online browsing. The resource center is divided into resource management, resource download and resource retrieval.

Based on the above business processes, the requirements of the system are analyzed. Based on the theory of Variable Order Fractional gradient descent method, a teaching system is established, including teaching management and terminal [8]. The teaching management subsystem mainly corresponds to the service terminal of the system, while

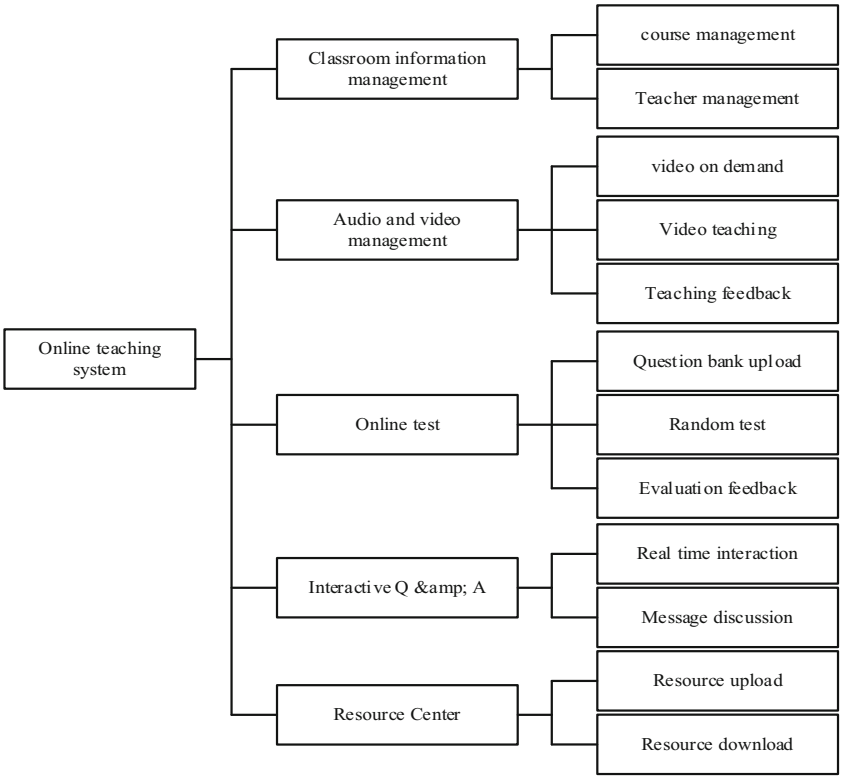

Fig. 3. Functional structure model of system software

the application of the terminal corresponds to the system client. The interface of the teaching management subsystem to teachers and administrators is mainly displayed on the basis of the interactive interface, which fully reflects the main functions of the interactive layer, and also shows the Moodle interface. The entrance of the teaching management subsystem is mainly the login interface. Users enter different personal details, and then verify the information. When the verification is correct, the next operation can be carried out. In the theory of Variable Order Fractional gradient descent method, there are two main options for users in their specific application. Users can use it online or offline [9]. The difference between the two application methods is that when online, it is a direct connection with the server, and only enter the user name and password. After verifying the login information, the user starts to apply the corresponding functions. The overall demand analysis results of the system are shown in Table 1, which is divided into 9 functional modules.

Table 1. Demand analysis

Serial number	Modular	Function
A	Account management	Distinguish user categories, etc.
B	Personal information management	User personal information maintenance
C	Programme Management	Teaching program management
D	Course management	According to different technical management courses
E	Training project management	Integrate into CD10 teaching mode
F	Teaching resource management	Including the overall management of teaching resources, video and other teaching resources
G	Teaching management	Teachers create classes and set directions for classes
H	Class management	Create classes and assign classes to students
I	System management	System data backup, etc.

In order to make teaching more meaningful, students evaluate and feed back the teaching of this course to teachers, score teachers' comprehensive performance, and get the corresponding evaluation results. Students make comments and suggestions on the problems in learning, and the teacher will reply after seeing the comments. According to the evaluation feedback, teachers modify their own teaching courseware, improve teaching methods, let students improve learning efficiency, and achieve the purpose of modern network online teaching.

2.3 Realization of Online Teaching of Variable Order Fractional Gradient Descent Method Theory

When designing a series of functions proposed by the online teaching system, the first is to select the development system and development framework selected by the system, and adopt a series of mature system components to speed up the development efficiency. After completing the above framework construction and component selection of the system, the next step is to code. Here, we need to design the common modules of the system first. The system adopts the general 3 + n design idea, that is, data access layer, business logic layer and user interface layer. Each layer is designed and divided into sub layers according to the complexity of specific functions. First, abstract the base class of data access operations commonly used in the system, and all business logic calls the data access layer to complete the required logical operations. The front-end page of the system adopts the theory of Variable Order Fractional gradient descent method for page design and layout. The system information display adopts the process of publishing from the background and displaying at the front-end, and the management and operation of

information in the background. In the system, the information design of the system is shown in Fig. 4.

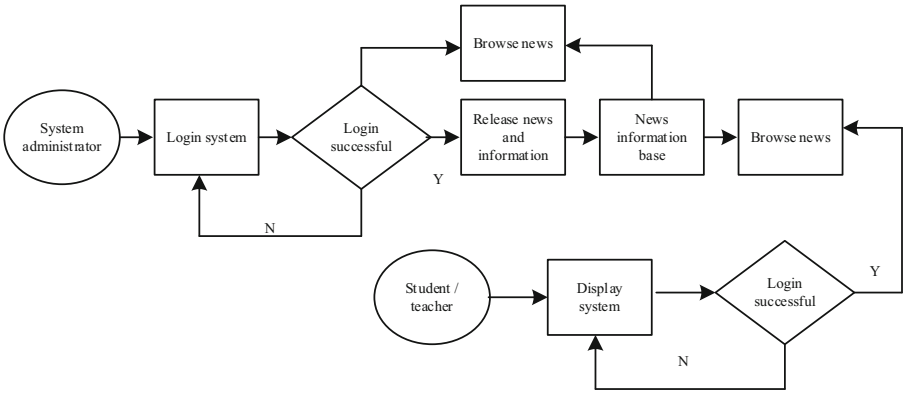

Fig. 4. Online teaching information management process

Software security is to take measures from the perspective of code to maintain the security of online teaching system and prevent illegal users from entering online teaching system. Therefore, the system introduces identity verification function and session timeout function [10]. When the user is not in the user library of the online teaching system, the user's login request needs to be rejected. In addition, when users do not operate for more than 30 min, they need to automatically jump out of the system to prevent other users from directly using the computer to enter the online teaching system to operate relevant functions, which will help to improve the security of the online teaching system. This encapsulates the data access base class. It should be noted that the system uses the NHibernate component for database access and persistence.Tomcat7 0 has built a basic system to form a unified access portal and a unified information display system. The software of this system is the operating system software and database system software installed on each server. The specific requirements are shown in Table 2.

Table 2. System softwar requirements

Software name	Accessory description	Quantity
Database	SQL SERVER2000	1
Middleware	Tomcat7.9	2
Report software	MicroStrategy	2

For the accelerated gradient descent method, such as momentum gradient method, the introduced variable y can accelerate the convergence speed of the algorithm, but λ When it is large, when it reaches near the extreme point, due to the large momentum along the original direction, it will cause serious overshoot and tremor and reduce the

convergence speed in the later stage of the algorithm. Resetting the controller in system theory can effectively weaken the overshoot and tremor in system control. An important function of reset control is to reduce the overshoot of the system and reset the integrator to zero when the system reaches the set value. In the gradient descent method, $\bar{t}$ is equivalent to the set value, so the reset momentum gradient method can be set as follows:

$$\begin{cases} \dot{x} = x\nabla_i f(\theta) - (\bar{t}) \\ \dot{y} = -y - \rho x \nabla f(\theta) \end{cases} \tag{1}$$

The idea of reset control is used to weaken the overshoot and tremor phenomenon in the accelerated gradient method, accelerate the convergence speed and improve the stability of the algorithm. The gradient descent method is the simplest and effective algorithm to solve the convex optimization problem. It has important applications in engineering practice, such as parameter identification, machine learning and optimization control. Some important concepts in convex optimization problems and the basic framework and convergence characteristics of the general gradient descent method are given: consider the following unconstrained convex optimization problem $\min_x f(\theta)$, which is a differentiable convex function with a unique global minimum point x and the corresponding minimum value is y. For this kind of problems, the gradient descent method can effectively search the minimum point ρ, As the name suggests, it is to iterate along the negative gradient direction φ_i to find the minimum value point of the function. The continuous gradient descent method can be expressed as:

$$\mathrm{z} = -\rho \sum \varphi_i - \min_x f(\theta)(\dot{x} + \dot{y}) \tag{2}$$

There are many different methods to prove the convergence of gradient descent method. Here, its convergence characteristics will be analyzed from the perspective of system. It is not difficult to see that the gradient descent method is a class of nonlinear feedback system, and its convergence is similar to the stability of nonlinear system. Therefore, the convergence analysis can be carried out by Lyapunov method. For the continuous gradient descent method, the Lyapunov function is taken as:

$$V(x) = \frac{1}{2\mathrm{z}} \|x - y\|^2 \tag{3}$$

The managers and relevant teachers in the education and teaching system of the theory of Variable Order Fractional gradient descent method should timely release the teaching resources related to the theory of Variable Order Fractional gradient descent method and the reference and registration materials of some large-scale competitions on the system. Therefore, it is necessary to better process and update the data of the teaching system. Timely unify the teaching of a series of courses, such as the theory of Variable Order Fractional step-down method, the theory of Variable Order Fractional step-down method, the related data processing program design of Variable Order Fractional step-down method theory, and the data processing program design of Android. In the theoretical education and teaching system of Variable Order Fractional gradient descent method, the administrator divides the course into multiple chapters for segmented teaching, and then fully protects the educational intellectual property rights while sharing

resources. In the system, students can choose appropriate theoretical courses of Variable Order Fractional gradient descent method according to their own learning needs, and select appropriate resources for systematic learning. The resource processing module of Variable Order Fractional gradient descent theory course is shown in Fig. 5.

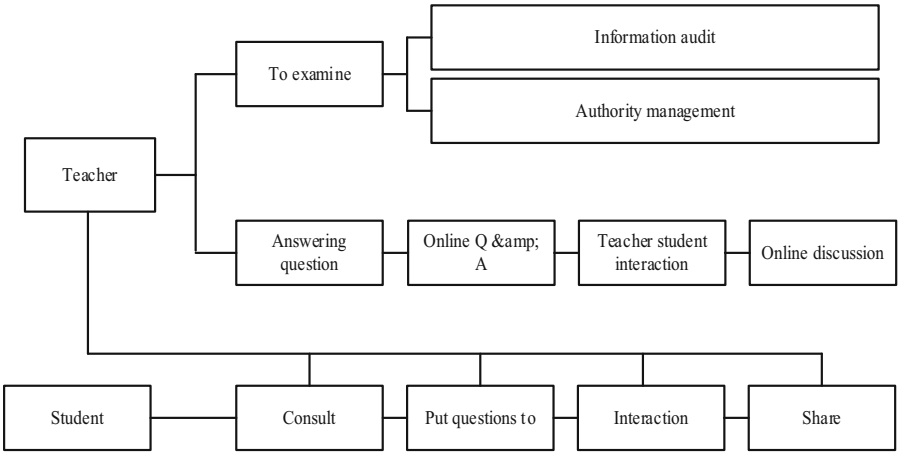

Fig. 5. Theory course resource processing module

The teaching resource processing module on the theoretical education and teaching system of Variable Order Fractional gradient descent method is shown in the figure. The system adopts dynamic course management mode, which is convenient to expand and adjust the course content at any time. In order to better integrate and classify teaching resources and facilitate the updating and storage of teaching resources, an online teaching system is designed as follows. The system builds an online learning and communication platform for students, which is divided into two subsystems: background management and foreground teaching. The main functional modules of the background management system are: administrator user management, authority management, role management, discipline management, class management, learning card management, chapter management and paragraph management; The main functional modules of the front desk teaching system are: user registration and login, viewing learning card, learning course, viewing questions, asking questions, answering questions and system message notification.

3 Analysis of Experimental Results

System testing is the work to ensure the system quality. It is the test of the whole product after the function development of the software product is completed. The purpose of system test is to verify whether the system meets the needs of users, so as to ensure the overall quality of software. System test is a black box test. The problems found in the test process should be debugged to find out the cause and location of errors, and then corrected. After correction, verification test should be carried out. Functional

test is mainly demand verification, The purpose is to ensure whether the final system implementation is consistent with the initial requirements analysis, whether it can meet the needs of users, whether the requirements are correctly realized, and whether the performance test is completed through stress test. The purpose is to verify whether the system performance can meet the normal operation of the system when multiple users access the system at the same time. The test environment is shown in Table 3.

Table 3. List of test environment

Serial number	Name	Hardware environment	Software environment
A	The server	Lenovo x3850	Windows XP
B	Client	Intel Core	Windows7
C	Network environment	Wan 150 Mbps	–

Functional testing needs to cover all demand points of demand analysis. The use case design of functional testing is a very complicated work. Each demand requires a large number of test cases to verify. The system has designed a total of test cases. Due to the space limitation of the article, some use cases are used to illustrate the functional testing process, and the user login test cases are used to verify the correctness of the user login function, See Table 4 for details.

Table 4. User login test cases

Test case name	User login function test
Test Manual	Enter the website address in the address bar; Enter the user name in the login interface; Input password; Click the “login” button to observe the interface changes
Expected results	Open the teacher user interface
Actual results	Consistent with expected results

According to Table 4, after the training plan is formulated, the teacher user can continue to carry out course management and training project management, and set corresponding task course management test cases for courses and projects to verify the correctness of the teacher user’s course management function, as shown in Table 5.

Table 5. Test cases of course management

Test case name	Course management function test
Test Manual	Enter the web address in the address bar; User login; Click the "management center" tab; Select course management
Expected results	Open the task list and display "duration" and other information
Actual results	Consistent with expected results

According to Table 5, In order to better test the performance of the system under high load, the system uses the loader runner tool to create multiple groups of different numbers of users to operate at the same time and record the reaction time of the system. The test items include: login system, online communication and online teaching. The test results are shown in Table 6.

Table 6. Login system test

Login system test case			
Prerequisite	Normal login interface		
Test target	Understand the performance of the system when multiple users log in at the same time		
Method	Use tools to simulate multi-user online communication scenarios		
Number of concurrent tests	Average time (s)	Maximum time (s)	Average use of network packets
40	1.325	3.652	71
70	4.652	6.989	76
210	5.658	9.658	100

According to Table 6 and Table 7, performance is an important part of the system. Corresponding performance indicators have been set in the demand stage, which are the focus of the performance test stage. If the test results do not meet the set goals, the online teaching system cannot be applied to the school to deal with relevant business. This can not improve the efficiency of teaching management, but will reduce the efficiency. Therefore, the performance test must be carried out before deployment. The online teaching system can be deployed to the school only when the performance test results are consistent with the requirements and objectives. During the test, LoadRunner software is mainly used for simulation test. According to the performance requirements, it needs to meet the concurrent access of 500 users. The test results are shown in Table 8.

Table 7. Online AC test

Online communication test case			
Prerequisite	Normal login system		
Test target	Understand the performance of the system in multi-user online communication at the same time		
Method	Use tools to simulate multi-user online communication scenarios		
Number of concurrent tests	Average time (s)	Maximum time (s)	Average use of network packets
40	1.325	2.652	74
70	3.655	6.325	75
210	5.652	12.325	81

Table 8. System performance test results

Number of concurrent users	Response speed (seconds)	CPU utilization (%)
60	1.45	1
120	1.46	2
180	1.55	3
240	1.55	3
300	1.63	7
360	1.73	8
480	1.98	10
540	2.12	18
600	2.36	21

For the software performance test under specific operating environment and load conditions, the system mainly focuses on the impact of the number of people online on the response time, as shown in Table 9.

According to Table 8 and Table 9, the performance test of the system is completed by checking the monitoring points in the performance test cases. It is very important to confirm whether the basic performance requirements of the system are met. In this online teaching system, the response time and throughput of the system are mainly tested.

To sum up, the following conclusions can be drawn from the functional test results and performance test results. The online teaching system meets the application requirements of the school, has comprehensive functions, and the performance is consistent with the goals set by the school. The system has no major defects, and there are no functional defects that affect the online teaching business. The problems found in the initial stage have been solved.

Table 9. Performance test cases

Test item	Number of people online at the same time	Expected average response time	Actual average response time
A	100	Less than 18	0.526
B	200	Less than 18	0.765
C	300	Less than 28	1.065
D	400	Less than 28	1.365
E	1000	Less than 38	1.998

4 Conclusion

The establishment of teaching system on mobile network mainly includes network teaching management system, which is mainly server terminal. Mobile terminal application subsystem, which is mainly the client. The specific application of these systems includes reusable development framework and data mining technology, which realizes the overall planning of mobile terminal, optimization design and Moodle to a certain extent. In this case, a relatively rich system module can be introduced into the system design. At the same time, it can also refer to the more robust background system to make the operation of different mobile terminals more convenient.

The innovation of the method is to optimize the hardware structure of the system, improve the operation performance of the hardware and optimize the software function of the system. This paper analyzes and discusses the current research situation in the field of online education, and completes the design and implementation of the online teaching system based on the theory of step-down method of variable grade. However, as for the design of online teaching system itself, there are still many places to be improved and developed. The next steps are as follows:

(1) Continue to study online teaching system, including online learning model, online teaching model, online education management model, virtual laboratory research in online education, the development trend of network education, campus network education application model research.
(2) In-depth discussion of educational technology research field and its development trend, educational software development standards and standard coding technology.
(3) Construct a cognitive student model to solve students' questions about intelligent teaching software and play the role of intelligent agent teaching application.

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