Design of a Web-based Personalized E-learning Platform

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Abstract. It is important to carry out the distant learning especially in the COVID-19 period when most of schools have to close down. Therefore, a Web-based personalized e-learning platform is presented to satisfy the requests of the middle school student. Firstly, the features of the learner’s needs for e-learning are analysed as the base of the platform. Secondly a novel architecture is proposed that describes the components necessary for the distribution of courses and knowledge in Internet. Thirdly the design of the platform is enabled by the real time collaboration system, multimedia transmission and knowledge repository to help the middle school student study in their own natural ways such as gaming and blogging with friends from interests. The experiment results show that the designed e-learning platform can improve the performance of network throughput and the learner’s satisfactory level.

1. Introduction
E-learning adopts the form of social reflection and can create "school of practice" to support efficient learning. In the e-learning environment, teachers make use of the huge horizontal energy and collective wisdom power of personal knowledge creation. This is based on the complementarity of learners' knowledge, experience, thinking mode and observation mode. Learners also include those who were previously not regarded as students in the learning process: friends, parents and other classmates, or scholars [1]. Higher levels of skills should be used to build truly complete learning communities by teachers so that all learners can give full play to your potential. In addition, the socialized e-learning community should support interactivity, interest and participation.

The current young students can be seen as the network generation because they grow up in the environment surrounded by all sorts of digital equipment. The natural links with the network technologies make this generation of students give them the capabilities to learn on line instead of staying in the classroom, which can expand the space of education anywhere[2,3]. Using the E-learning education platform, students can query their learning progress at any time, preview and review, upload their own homework. Teachers can perform online tutoring, further optimize the current learning resources, change the previous education methods, improve the efficiency of teaching, and give play to the significant advantages of network technology in education.

E-learning resources can enrich students' vision and cultivate students' all-round knowledge. The world is actively developing E-learning learning platform, and a large number of extended functions are integrated in the platform, including students' successful login to the platform to make online presentation for class. The application of three-dimensional laboratory just cultivates students' ability to do laboratory on site to some extent[4], it not only saves the cost of educational resources, but also experiences the great advantages of information technology in distance education.
In the E-learning environment, teachers will no longer be the main master of teaching, this role will be undertaken by students. Students' participate in the whole learning process as the active builder of knowledge learning, and optimizes the teaching mode by emphasizing the interaction among teachers, students, media and teaching content[5]. The E-learning platform designed in this paper can register the information of teachers and students on the platform, and can also provide a distance education community for a school to provide opportunities for distance education within the school.

2. Request analysis

The combination of the actual school and the virtual campus is the general direction in the world, that is to use the dual mode of E-learning education, and its ultimate goal is to achieve the goal of interactive network learning. The E-learning mode is applied in distance learning, online course making and virtual experiment. Meanwhile, the mode can also help participants understand the importance of team learning and research learning, and manage students' learning behaviour and network courses.

The personalized E-learning platform is implemented in B/S mode, which is one of the key points of the system. The platform realized by this architecture has advantages in many aspects, especially in the interactive ability of the system, as well as the network service quality and system scalability. The platform will also provide dynamic and real-time multimedia information, conduct real-time online lectures and remote teaching, realize large-scale and high-quality video on demand through the interactive environment of immersive wide area network, and develop the education information resource database to a new height. At the same time, the systematic new education and teaching concept has played a very important role in learners' initiative and personalized exploration of learning.

As the E-learning itself will lead to changes in teachers, educational organization and process, it will give rise to the conflicts of some power and interests, and some people maybe resist the new system. However, from the perspective of the implementation of modern E-learning system, the realization of the expected functions will not only bring convenience to teachers, but also provide convenience for learning and training.

The personalized teaching service, diversified teaching forms, real-time teaching quality evaluation system and interactive teaching forum realized in the E-learning platform are the characteristic functions of this system which are different from other distant learning systems. According to the characteristics of the E-learning platform and the multi-user operation[6], the realization of the E-learning management needs to adopt the multi role and multi-user type of operation. According to the different user types, the E-learning platform can operate their respective management modules, which makes the authority and division of users more clear, System users are classified under the condition of fully considering the business requests of the system. The specific user objects are divided into four roles: tourists, students, teachers and system administrators. Each role has different operation object and scope under their own authority.

For the tourists who are not members of the E-learning system, they do not need to register. They can directly log in, query and browse some trial resources related to the course or courseware video. Tourists don't need identity authentication. They only have the function of browsing some web pages of the system. They can view the abstracts of all course contents and some statistical information, which includes the comment information for teaching interaction. They only have the lowest authority to browse the latest education news and check the latest content introduction of excellent courses.

The members who have registered as students in the E-learning platform have the limited system operation authority and learning authority after being approved. They can browse and modify personal information, view various course categories and detailed information, query teaching information and teachers' profile, select teachers, take online examination operation, answer questionnaire questions for teaching quality evaluation, and upload / download courseware. Furthermore, they can complete the operation of online assessment, the on-demand of course video and the interaction of problems after learning the course, the evaluation of the course and the recognition of teachers' qualification. Students
can only modify information related to themselves to ensure the safety and integrity of personal information.

Teachers can modify personal information after they complete personal information authentication. Teachers can manage the modules operated by individuals, including the upload and download of personal certificates, and achieve the certification of personal qualifications through the system. They can also manage the course type and course content maintenance. The learning information can be provided through the creation and maintenance of courseware video. Additionally, the main function of the platform is online learning, which can make learning process more distinctive by interactively replying to comments of students. The teacher is an important decision-maker in the issue and topic selection of the online examination. The teacher has the right to choose the type of test questions, the difficulty of the test questions and the test date.

The system administrator charges of the management of students and teachers, the audit of new students and teacher identity authentication, etc. Through the information maintenance of relevant users, it is convenient to control the type and number of users in the system. The system administrator can maintain the types of courses and courseware in the system. He also has the permission of uploading and downloading of video courseware, the management of teacher qualification information, the maintenance of interactive teaching module, the configuration of examination information and the setting of online examination. He can also set some system configuration, such as permission management, session time, test difficulty setting, etc. the system administrator has all the rights of the system, who is the highest level in the system.

3. Proposed architecture
The E-learning platform is based on the B/S architecture. In order to satisfy the needs of concurrent development, quick maintenance and flexible expansion, the overall structure design of the system adopts layered technology, which divides the system into three layers: presentation layer, business logic layer and data layer. Each layer of the architecture is explained below and shown in figure 1.

![Proposed Architecture](image)

The presentation layer is on the outermost layer (the top layer) and is closest to the user. It is used to display data and receive user input data, and provide an interactive operation interface for users. It mainly completes the functions of client view display and data verification, including: display the data in the form of friendly user interface, verify the integrity and validity of the input data, and save the data in the specified format.
The business layer realizes the logic functions including user management, course management, information retrieval, on-demand management, online examination management, authority management, personalized customization, log management, etc. This layer is between the presentation layer and the data access layer. The business data is accessed through the data access object of the data layer to provide data support to presentation layer.

The data access layer is the basis of the system. It is the operation layer of formatted data in the form of database, text file, multimedia data and knowledge storage, rather than the original data. It provides the interface of various operations on the database.

The common modules layer is a common class abstracted from all the public methods in the presentation layer, business layer and data layer.

4. Platform design

According to the needs of modern distance education system and the analysis of request analysis, the system flow chart is sorted out as shown in Figure 2. The administrator completes the arrangement of teaching process, management and release of course video. Teachers teach according to the administrator's arrangement, and interact with students through some auxiliary tools. Students can directly obtain the video materials related to their selection course from the server through information retrieval, and learn by on-demand teaching. At the same time, they do homework and information feedback according to the information released by auxiliary tools.

![Flow of e-learning system development](image)

Figure 2. Flow of e-learning system development

Personalized customization is the main feature of this system. It first analyses the students' personal interests in detail, then searches for the corresponding learning materials, uses the collaborative filtering algorithm to filter and select the courses in time, and then automatically obtains the most suitable course materials and recommends them to the students, which can further reduce the time for students to screen information and better serve the students. Design of the personalized customization is shown in Figure 3. There are two main parts in the personalized customization function of the E-learning platform, which are student analysis and course recommendation.
Knowledge repository prepares huge and rich learning resources for personalized recommendation module.

The main functions of the student analysis part are as follows, the results of the student analysis are stored in user characteristics database:

- In the process of using personalized service, the system can remind students to register the content they are interested in, and the system can also collect and save the things they are interested in automatically.
- After a student user profile is prepared, it can still be modified, so that the content of the system is dynamic, and the data can be updated with the change of students' needs.
- The system will take the initiative to carry on the statistics of the user information according to the analysis of the student's learning activity, further perform the renewal to the student interest weight.

![Diagram](image)

**Figure 3. Design of the personalized customization**

In the data pre-processing part, the main function is to pre-process the user's initial record for association analysis. When a student uses the E-learning system to learn, there may be some association between all the pages he visits, which is determined by the logical relationship between the knowledge topics stored in the page. For example, when a user browses a certain knowledge topic, the user may need to visit other knowledge topics related to the page. The association between pages can be established through two aspects: on the one hand, it can be automatically adjusted according to the visit records of most students; on the other hand, it is made in advance according to the teaching experience and the connection between knowledge topics.

The "transaction itemset" in association rules of student access refers to the collection of knowledge topic pages stored in personalized E-learning system. The frequent transaction itemset discovered by association rules is the frequently visited knowledge topic page set. The ordered access path formed by frequent access to transaction itemset is called frequent access path. Association rules are used to mine these transaction itemsets and frequent transaction itemsets, and the obtained patterns can recommend the matching learning resources for users.

The personalized recommendation is the process of matching the user session segment with the generated frequent transaction itemset. The process will produce association rules that meet certain support and confidence level, and the page set generated by all these association rules is the recommended student visit page collection.

**5. Implementation and performance test**

System testing is a very important part in the design process of E-learning platform. The system test results have a very important impact on the design quality, function realization degree and system stability of E-learning platform. Therefore, combined with the actual needs of E-learning system, as well as the design objectives, the performance test and system integration analysis are carried out.

The system testing work selects a large number of data as the input of the system, and ensure that the information input is correct. In such an environment, it can fully ensure that the system can get the most standardized test in a fair and formal software operating environment, so as to ensure that the system can be delivered on time and stable operation.

Analysis of the platform performance will help designer to take efficient decisions about how to purchase the hardware resource. Some performance indexes related properties which can be analysed.
are throughput, utilization of different components and their activities and the response time. Some of these have been practiced with the platform and the results are discussed in this section.

In our case study throughput of deliverLSN activity, which is the last activity after learner’s request message, is the satisfaction factor for the client. Throughput of this activity with different number of database server (DBServer) components is depicted in figure 4 and shows that having three number of DBServer component in system is a wise decision, which is the most cost-effective.

Sensitivity analysis is a type of analysis with regard to performance which shows the effect of changing some parameters in the system. Figure 5 shows the effect of different values for checkValid operation which is the security processing center in the model. This result shows that there is a slope in throughput improvement with changing the execution time of checkValid, hence checkValid execution values higher than this slope doesn’t affect the system performance.

6. Conclusion

E-learning is a very hot issue during COVID-19 period for promotion of learning. The E-learning platform designed and implemented in this paper can not only provide unlimited space for students to choose, but also enable them to choose the most suitable learning method through a variety of multimedia forms. Compared with classroom learning, it has a better learning atmosphere. Compared with the traditional distance learning system, it has more targeted in-depth guidance. The system can teach students in accordance with their aptitude, provide personalized learning tutoring and recommend learning content for students.

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