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An Urban and Rural Educational Resource Sharing and Exchange Platform Based on Cloud Platform Access Technology

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ABSTRACT

A challenge for realizing the sharing of excellent urban and rural educational resources is how to break through the time and space limitations. This study attempts to answer this question by proposing a mobile educational resource sharing and exchange platform based on the cloud platform access technology. Further, this paper conducted simulation experiments on the proposed cloud platform and attained the evaluation scores of the operation convenience, resource quality, and sharer school reliability given by student users. Results of the simulation experiment suggest that the proposed model can effectively improve the learning efficiency of both urban and rural students and break through the limits of space and time.

1. INTRODUCTION

Balance the development level of education in urban and rural areas is an evitable path to modernize China's education, and it is an important content in the national strategy of rural revitalization. However, the sharing of excellent urban and rural educational resources is always a big problem and it's hard to break through the limits of space and time. However, the development of Internet education and online teaching and learning platforms in recent years has provided a new chance for the sharing and exchange of urban and rural educational resources.

In terms of solving education imbalance and realizing resource equilibrium, field scholars have conducted various studies from multiple perspectives. For instance, Feng et al. [1] proposed to make full use of the education platforms to allow rural students to enjoy urban educational resources, in this way, the quality of rural education could be improved. Zeng and Qiu [2] believe that the unbalanced development of urban and rural education in China is affected by uneven educational resource allocation, insufficient input in rural education, incomplete educational system, and the incompetent faculty construction. Xue and Li [3] hold that the unbalanced flow rate of urban and rural volunteer teachers in China has further curbed the integrated development of urban and rural education, and the balanced distribution of teachers in urban and rural areas is the key to achieving balanced development of compulsory education. By analyzing these literatures, it's found that the sharing of educational resources through cloud platforms can greatly narrow the gap between urban and rural educational resources.

The interaction functions of existing online education platforms stay in simple online interactions such as online forums and instant messages, the interactions among learners, instructors, resource providers, and learning resources are mostly synchronous or asynchronous communications on the Internet [4]. Shortcomings of present platforms can be summarized as: the construction of educational resources lacks overall planning and design standards; builders of distance and open educational platforms lack effective communication and cooperation; the sharing of educational resources stays at a low level; redundant projects are constructed repeatedly and cause huge resource wastes; and the chaotic storage layout of educational resources increases the burden on learners [5]. The distance educational resources are generally stored on the servers of each educational institution, forming independent islands of resource systems that are difficult to access [6, 7]. Learners usually hope to access to various learning resources through one platform and not have to spend much time on searching. The educational resources of cloud platforms have diverse formats such as texts, audios, and videos, which can be viewed via mobile terminals from anywhere at any time. The resource access process should be more continent and efficient, and won't be interrupted by the maintenance of the platform, the resources can be automatically uploaded to other servers for backups. The cloud computing developed based on distributed computing and storage can quickly process and respond to user tasks without occupying high-performance servers. The processing of large tasks is completed by the joint efforts of multiple low-configuration servers maintained by the technical layer, which can effectively improve the intelligence, reliability, and cost-effectiveness of the educational resource sharing platform. Learner users can visit the resource information they need from mobile terminal devices or PCs and use the cloud computing function provided by the platform [8, 9]. In this context, this paper proposes an efficient, open, shared and interactive cloud platform for educational resource sharing in urban and rural areas based on the could platform access technology, in the hopes of providing theoretical and practical evidences for breaking through the limits of space and time and realizing education equity in the end.

The rest chapters of this paper are arranged as follows: Chapter 2 gives a theoretical analysis of the centrality, density, architecture, and storage of the sharing network of urban and rural educational resources on the cloud; Chapter 3 discusses the realization of the sharing of educational resources on the proposed cloud platform; Chapter 4 analyzed the data attained from the simulation experiments; the last chapter summarizes the research conclusions.

2. THEORETICAL ANALYSIS

2.1 Cloud educational resources of urban and rural schools

Present online education platforms of urban and rural schools share a few common merits such as diverse products, high frequency of use, clear objectives, concentrated information channels, and good effect in assisting learning; however, there're also a few problems with them such as the expensive charge on high-quality educational resources, the richness and convenience of high-quality educational resources need to be improved, and the understanding of the requirements of teachers and students is insufficient, etc. [10]. In view of these problems, optimizations could be made from aspects such as developing inclusive and free-of-charge educational resources, enriching content and improving convenience, and fully mastering the requirements of teachers and students [11]. In the urban-rural high-quality educational resource sharing model proposed in this paper, the mentioned educational resources are inclusive and free-of-charge, students' requirements could be attained from the content they learnt and the exercises they took; the passing on of high-quality educational resources could be encouraged via students' learning scores and efficiency, and the cloud platform can act as bridges for the communication between urban and rural students.

The sharing network is consisted of the educational resources of each school in the urban and rural areas. Multiple groups co-exist in the sharing network, a group usually contains schools in both urban and rural areas, there're competitive and incentive mechanisms between groups and within groups. Through qualitative and quantitative analysis of each school, the similarity of two or more schools in the network was matched, and each school's high-quality educational resources were predicted and evaluated to make preparations for the sharing. However, attentions should be paid to the matching principles, which should emphasize on the complementarity and diversification of resources, not alliance between giants in the same direction. Although students from different schools would form a social circle, the actual distances between members in the circle are different, so this social circle of students is mainly used for mutual learning and communication [12].

2.2 Centrality of urban and rural schools

The concept "educational centrality" proposed in this study is an extension from the concept of network centrality, it is used to distinguish the importance of each school in the sharing of high-quality educational resources, the higher the browse frequency of resources shared by a school, the greater the importance of this school, and the greater the influence of it [13]. A higher centrality of an urban school and a rural school indicates closer connection between the two. When a school is directly connected to most of the other schools or of a high acceptance degree, then it means that this school is an important node in the sharing network of high-quality educational resources, and it plays an important role in communication, exchange, resource sharing, and mutual learning. Educational centrality can reflect the status of a school's high-quality educational resources to a certain extent [14], however, since the original intension of this paper is to mobilize the enthusiasm of urban and rural schools as much as possible, the number of schools with educational centrality shouldn't be either too large or too small.

2.3 Resource density of urban and rural schools

The concept "resource density" of urban and rural schools proposed in this study is an extension from the concept of network density, it is used to indicate the sharing frequency of high-quality educational resources between urban and rural schools. A higher resource density means that the sharing frequency of high-quality educational resources between urban and rural schools is higher; and the lower the resource density, the lower the sharing frequency. Same as network density, the possible values of resource density of schools are between 0 and 1. If there're direct connections between the high-quality educational resources of urban and rural schools, then the maximum value of resource density is 1, but in most cases, its value is less than 1, just as is the value of network density.

On cloud platforms, the density of educational resources is often used to measure the frequency and trend of resource sharing. For an educational resource shard by N schools and via L actual sharing paths, its educational resource density is [15]:

$$d(G) = \frac{2L}{N(N-1)} \tag{1}$$

The value range of educational resource density is [0, 1]. When an educational resource is fully connected, d(G)=1. When there is no connection to this educational resource, d(G)=0. However, in reality, schools with a resource density of 1 do not exist, and the actual maximum density is always less than 1 [16]. Under normal circumstance, the resource density of large-scale schools is lower than that of small-scale schools. The resource density values of schools of different sizes cannot be compared directly, but can be compared using the absolute density formula.

$$d(G) = M / [4SR^3 / 3D] \tag{2}$$

where, M represents the resource diameter, SR represents the resource radius, and D represents the circumference calculated from the diameter.

The resource density of a school is actually the ratio of the actual number of shares to the possible number of shares. Assuming: G represents the directed graph of high-quality educational resources between urban and rural schools, then the resource density D could be calculated as:

$$D = \frac{k}{K(K-1)} \tag{3}$$

where, k represents the actual number of shares; K represents

the number of participants in resource sharing; density D represents the degree to which the schools are interconnected, it can be used to measure the speed of information exchange.

2.4 Framework of the proposed model

Figure 1 gives the basic structure of the high-quality educational resource sharing cloud platform of urban and rural schools proposed in this paper. The proposed model contains a management layer, a technical layer, and a resource layer.

(1) Management layer: this layer is responsible for managing the resources of the entire cloud platform, including the accounts and passwords of student users, and prompts of learning efficiency and progress; this layer also has the responsibilities of managing all kinds of permissions and planning the development of the entire cloud platform.

(2) Technical layer: this layer is responsible for storing and sharing the cloud educational resources, maintaining the cloud platform and upgrading the inventory, developing new functions and maintaining existing functions, as well as designing eye-pleasing network pages and ensuring smooth use and browse.

(3) Resource layer: this layer is responsible for collecting various learning resources and integrating high-quality resources shared by each school; based on the resource-sharing groups, it is also responsible for recommending high-quality educational resources to student users, pushing educational resources that are frequently studied or searched by them, and sorting out, saving, and updating the resources in an orderly manner.

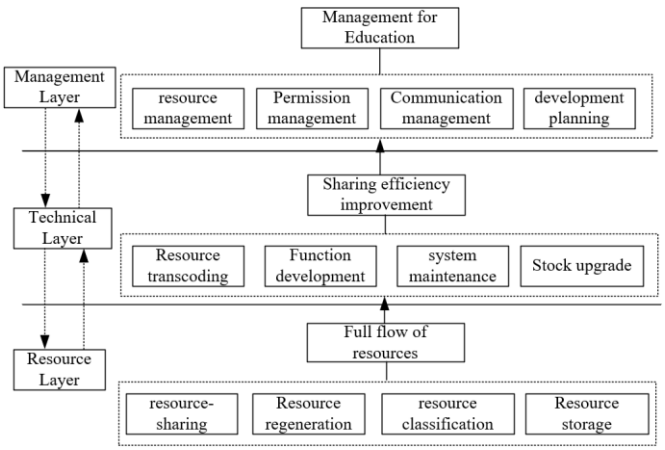

Figure 1. Structure of the proposed platform

2.5 Sharing, storage, and management of cloud educational resources

The distance educational resource sharing platform built based on cloud technology is a large scale data center, not just a single web server for commercial use [17]. It consists of educational resources shared by urban and rural schools and can be easily accessed via Internet. The platform connects urban and rural schools in various regions and realizes the sharing of different high-quality educational resources on the cloud. The technical layer fixes existing loopholes and develops new functions according to the requirements of cloud educational resource sharing. The management layer controls the dynamics of the entire system, predicts the future development direction of the system in time, and corrects the possible errors in a timely manner. The structure of the sharing and storage functions of the cloud platform is given by the following Figure 2:

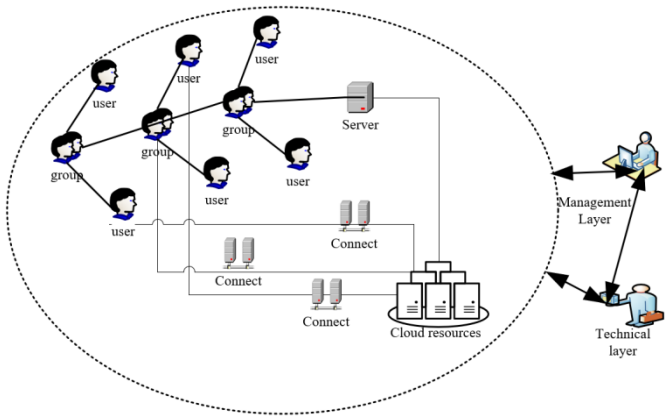

Figure 2. Structure of the sharing and storage functions of the cloud platform

3. REALIZATION OF EDUCATIONAL RESOURCE SHARING ON CLOUD PLATFORM

In this paper, the sharing strength between schools is used to describe the resource similarity between schools [18]. $C_{(m,n)}$ represents the sharing strength between schools m and n, then their sharing strength could be calculated as:

$$C_{(m,n)} = C_{(m,n)old} + (1 - C_{(m,n)old}) \times C_i \tag{4}$$

where, $C_{(m,n)}$ represents the sharing strength between school m and school n in the last sharing; C_i is an initial value, according to previous experience, its value was set to 0.56 in the simulation experiment, and the decay component was calculated by the following formula:

$$C_{(m,n)} = C_{(m,n)old} \times \alpha^t \tag{5}$$

where, α represents the decay index, which was set to 0.96 in this experiment.

The sharing speed-change component could be calculated as:

$$C_{(m,\omega)} = C_{(m,n)old} + (1 - C_{(m,n)old}) \times C_{(m,\vartheta)} \times C_{(\vartheta,m)} \times \beta \tag{6}$$

Parameter β describes the dependency between schools, according to previous experience, its value was set to 0.28 in the experiment.

The PageRank algorithm was adopted to calculate the centrality of schools, assuming $P_{(m)}$ represents the centrality of school m, then it can be expressed as:

$$P_{(m)} = \frac{1-d}{k} + d \sum_{\vartheta \xi N(m)} \frac{P_{(9)}}{K_{(9)}} \tag{7}$$

where, parameter d represents the decay factor, according to previous experience, its value was set to 0.35 in the experiment; $N_{(m)}$ represents the number of nearby schools that share resources with school m.

According to the weighted squared Euclidean distance between data samples and the cluster centers, the objective

function was minimized to attain the membership degree and the cluster center, and the objective function of clustering could be expressed as:

$$\min L_f = \sum_{i=1}^{K}\sum_{j=1}^{Q} Z_{ij}^f \left\| t_i - v_j \right\|^2 \tag{8}$$

The objective function was constructed using the measured fuzzy membership and dissimilarity, and the minimum membership degree and cluster center of the objective function were found through iterations to realize sample classification:

$$\begin{aligned} J &= \sum_{i=1}^{K}\sum_{j=1}^{Q} m_{ij}^f \left[d^2(T_i, n_j) + G_{ij} \right] \\ G_{ij} &= \sum_{\beta=K_1} \frac{1}{d_{i\beta}+1}(1-\mu_{i\beta})^f \end{aligned} \tag{9}$$

At last, the optimal solution of the objective function was calculated as:

$$\begin{aligned} m_{ij} &= \frac{1}{\sum_{l=1}^{Q} d^2(t_i, n_j) + G_{ij} / d^2(t_i, Y_i) + G_{il}} \\ n_Q &= \frac{\sum_{j=1}^{Q} m_{ij}^m t_i}{\sum_{j=1}^{Q} m_{ij}^m} \end{aligned} \tag{10}$$

3.1 The reference algorithm

Considering the organizational characteristics of schools participating in the educational resource sharing, this paper referred to a distributed school centrality algorithm which is especially suitable for networks with asymmetric interaction, it is not only conducive to improving the efficiency of resource sharing, but also can facilitate the management of schools with centrality [19]. By minimizing the Frobenius norm in the objective function, the changes of each link and the scenarios that can directly affect the objective function could be considered during the sharing of cloud educational resources, and the algorithm below gives the calculation steps.

Algorithm 1: The distributed school centrality algorithm

① \begin{align*} \underset{\mathbf {X}\in \mathbb {A}_{\mathcal {G}}}{\min }\quad &\frac{1}{2}\Vert \mathbf {X}\Vert _F^2 \\ \text{subject to} \quad & \mathbf {W}+\mathbf {X} \leq \overline{\mathbf {W}} \\ &\mathbf {W}+\mathbf {X} \geq \underline{\mathbf {W}}\\ & (\mathbf {I}_N-\alpha (\mathbf {W} + \mathbf {X})^T)\boldsymbol \rho _\alpha ^* = \mathbf {z}.\tag{29} \end{align*}

②\begin{align*} \underset{{\bf X}_i\in \mathbb {R}^N}{\min } \quad &\frac{1}{2} {\bf X}_i^T {\bf X}_i\\ \text{subject to}\quad & \mathbf {W}_i+\mathbf {X}_i \leq \overline{\mathbf {W}}_i \\ &\mathbf {W}_i+\mathbf {X}_i \geq \underline{\mathbf {W}}_i\\ & \rho _{\alpha i}-\alpha (\mathbf {W}_i + \mathbf {X}_i)^T)\boldsymbol \rho _\alpha ^* = {z}_i \tag{30} \end{align*}

4. PROCESS AND EFFECT OF THE SIMULATION EXPERIMENT

4.1 Sharing platform selection

This paper studied a cloud-based sharing platform that integrates multiple functions including resource sharing, resource query, chatting and friends-making, and technology development. Main interfaces of this platform are composed of the algorithms of function setting, resource mode, resource sharing, chatting and friends-making, and function suggestion. Variables of educational resources set on the cloud platform mainly include: scope of educational resources, number of schools, maximum resource sharing scope of rural schools, size of resource sharing interval of rural schools, resource upload frequency of schools, resource update efficiency, and resource retention time, etc. The proposed cloud platform has integrated the most representative functions such as resource storage, resource sharing, chatting and friends-making, and function development.

We invited 30 students from 6 schools (3 in urban areas and 3 in rural areas) to use the proposed platform and carried out simulation experiment. The experiment lasted for one month, and the scores of operation convenience, resource quality, and reliability of sharer schools given by the 30 student respondents were collected as experimental data. The score range was 1-5 points, and higher score indicates better evaluation, all scores were summed and averaged and 3 datasets were attained in the end.

4.2 Analysis of learning efficiency

This paper holds that the student users of the cloud platform know exactly what educational resources they and other students have. If a student is in lack of an educational resource, he/she may initiate a resource sharing request, and the schools or other students who receive the request can respond if they have that educational resource. If a student finds that a resource cannot be used normally, he/she can report the situation to the resource sharer and request to upload the resource again. When other schools receive the related request messages, they operate similarly.

Based on the collected data, this part analyzed three dimensional efficiency evaluation of urban and rural students on the cloud platform, and studied the scores of operation convenience, resource quality, and reliability of sharer school given by the student respondents. Among the three evaluation dimensions, operation convenience refers to the time it takes for a student user to reach the required resource after opening the software and the complexity of the operations performed by the user, student respondents were asked to combine these two aspects to score this dimension. Resource quality refers to the degree to which the shared educational resources can help student users understand and absorb knowledge, the student respondents were asked to score this dimension based on their own feelings. The reliability of sharer school refers to whether a school in close cooperation in a sharing group can upload the resource in time and whether the quality of the uploaded resource is satisfactory or not.

4.2.1 Analysis of operation convenience

Figure 3 shows the scores of the operation convenience of the cloud platform given by urban and rural student users. With the passing of experiment time (the experiment lasted for 30 days, each 5-days was taken as a group, same below), overall speaking, the scores of urban and rural students showed a trend of increasing first, decreasing later, and rising again afterwards. The figure below clearly shows that the evaluation score of operation convenience given by urban students is higher than that given by rural students, this is

because the economic conditions of urban students are better and they have more opportunities to access to electronic products. On the whole, the scores given by student respondents are relatively high, so it can be judged that the operation convenience of the cloud platform is basically recognized by urban and rural students.

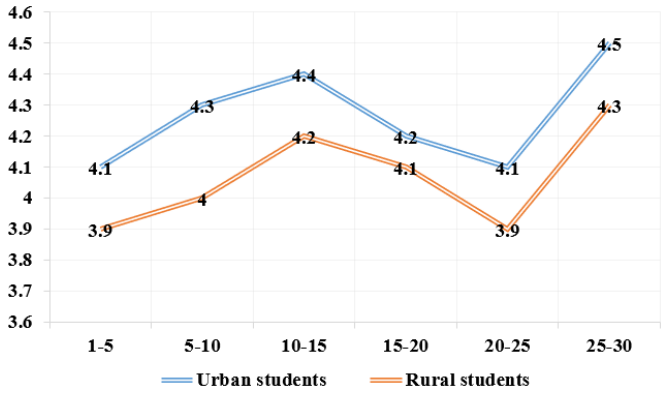

Figure 3. Scores of operation convenience of the platform given by urban and rural students

4.2.2 Analysis of resource quality

Figure 4 shows the scores of resource quality given by urban and rural student users. The figure clearly shows that the evaluation score of resource quality given by rural students is higher than that of urban students. Since urban students have better educational conditions, their requirements for various types of educational resources are higher, so they tend to give lower scores on resource quality. In the initial stage of the experiment, the quality score of the platform exhibited a growing trend; then in the middle stage, the score leveled off, neither increased nor decreased; in the last stage, the score continued to increase, so the evaluation score also showed a trend of increasing first, decreasing in the middle, and growing again at last. On the whole, the evaluation score of urban students is relatively high, and student respondents are satisfied with the resource quality of the platform.

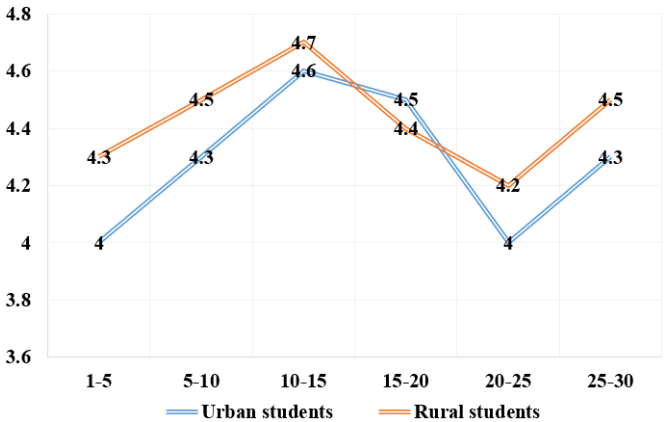

Figure 4. Scores of resource quality of the platform given by urban and rural students

Resource quality is the key to educational resource sharing, only good enough resources can promote the development of urban and rural education, thereby realizing the modernization of education in China. If the quality of shared educational resources cannot be guaranteed, the existence of cloud platforms would lose its meaning, and it will be a waste of educational resources. Although all educational resources are shared, considering that educational methods may vary in different areas, this paper proposed a combinatorial mode for the sharing of educational resources between urban and rural schools. One thing we need to note is that advantaged schools may have disadvantages in their educational resources, and disadvantaged schools may have advantages in their educational resources, and sharing process is actually a complementary process.

4.2.3 Analysis of sharer reliability

Figure 5 shows the scores of the reliability of sharer schools given by urban and rural student users. Although it's mentioned in the beginning of the paper that all the educational resources are shared, there're school pairs who help out each other, and they both have their own strengths and weaknesses. As a result, the student respondents gave evaluations on the resources shared by the partner schools.

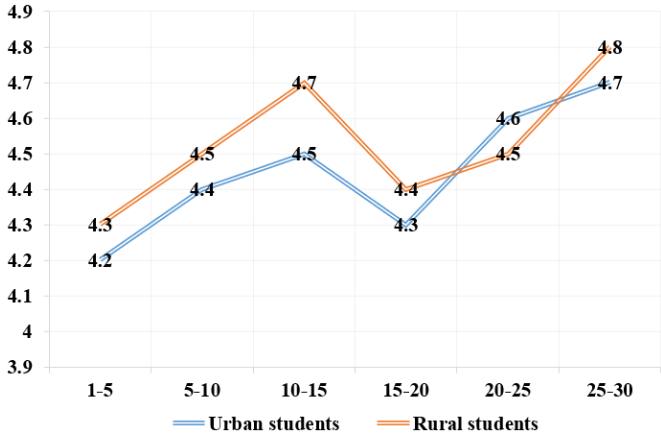

Figure 5. Scores of sharer school reliability given by urban and rural students

As can be seen from the figure, on the whole, the evaluation score of sharer reliability given by rural students is higher than that of urban students. This result can be attributed to several reasons, at first, urban students generally have access to more educational resources and rural students have fewer educational resources; secondly, the differences in education environment and family income also have an impact on the result; thirdly, the sharer reliability score is also affected by the input of shared educational resources, when the input of shared educational resources increases in the initial stage, the sharer reliability score increases as well; then in the middle stage, the input increases continuously, but the reliability score decreases; in the later stage, as the input increases, the reliability score increases again.

5. CONCLUSION

This paper proposed an educational resource sharing model based on cloud platform. After analyzing the existing resource sharing cloud platforms and their characteristics, this paper proposed an educational resource sharing platform for urban and rural schools. The proposed platform is easy to operate, and is approved by student users for its resource quality and the reliability of sharer schools. The simulation experiment also suggested that the proposed platform is worthy of promotion. Our research results reveal that the proposed

platform is acceptable for both urban and rural students, and their evaluations on it are good. The proposed platform can make up for the problem of unbalanced distributed educational resources in urban and rural areas to a certain extent, but this requires the government to take a lead in building such bridges, otherwise it will be difficult to establish, let along to develop in the long run.

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