Research Article

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Fuzzy comprehensive evaluation model of interuniversity collaborative learning based on network

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Abstract: Learning evaluation is an effective method, which plays an important role in the network education evaluation system. But most of the current network learning evaluation methods still use traditional university education evaluation system, which do not take into account of web-based learning characteristics, and they are difficult to fit the rapid development of interuniversity collaborative learning based on network. Fuzzy comprehensive evaluation method is used to evaluate interuniversity collaborative learning based on the combination of fuzzy theory and analytic hierarchy process. Analytic hierarchy process is used to determine the weight of evaluation factors of each layer and to carry out the consistency check. According to the fuzzy comprehensive evaluation method, we establish interuniversity collaborative learning evaluation mathematical model. The proposed scheme provides a new thought for interuniversity collaborative learning evaluation based on network.

Keywords: Fuzzy comprehensive evaluation, interuniversity collaborative learning, evaluation index

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1 Introduction

The enhancement of the higher education quality needs teaching reform and innovation. The development of information technology has provided the powerful support for the way to improve study. Collaborative study of interuniversity based on network is a new exploration of high education reform [1]. It is one of the most important interuniversity collaborative aspect among universities, a new learning method to promote the teaching quality and the students’ full development in teaching domain, and an extension of web-collaborative study without changing the present teaching mode [2]. It is also a special practice in a collaborative study, which enlarges the collaborative objects and enables the learners to build broader knowledge foundation and have even larger mutual learning space [3].

In the late 20th century, information technology represented by a computer got rapid development. Multimedia technology and network technology further promote the human purposeful interaction and collaboration between social groups. Computer supported cooperative work provides a new collaborative learning enlightenment. Computer supported collaborative learning (CSCL) uses computer technology, especially multimedia and network to assist learning [4]. This is a cross research field based on a collaborative learning and computer supported cooperative work. In CSCL research practice, there are many excellent learning support platforms based on network environment. Web-based collaborative learning is an extension of the CSCL, which refers to the use of Internet network technology to support collaborative learning and is also called WebCL abroad [5]. In this sense, WebCL is a subset of CSCL. It includes E-mail, multimedia conference system, collaborative document editing, remote collaborative learning system, etc [6, 7]. The inter-university collaborative learning based on network is a realization of CSCL on network platform, so that the theory and principles of CSCL can completely guide the practice of the present study.

Interuniversity collaborative learning based on network uses Internet to perform common curriculum learning activities and focuses on the difference between various university learning aspects [8]. It learns this difference and uses it in the study process, thus deepening on the understanding of knowledge and mutual understanding, or providing comprehensive experiment project development [9]. Through collaborative team efforts, it jointly solves the problem similar to the real situation. In the
learning activities with these characteristics, partners who participate in the learning, show a kind of coordinate, cooperation relation, which is called the interuniversity collaborative learning based on network.


In the next section, interuniversity collaborative learning network model is put forward. In section 3, fuzzy comprehensive evaluation for network based interuniversity collaborative learning is investigated. In the end, some conclusions are given.

2 Interuniversity collaborative learning network model

Web-based interuniversity collaborative learning platform is actually a comprehensive teaching system based on Internet. The construction of the system can use C/S (Client/Server) mode and B/S (Browser/Server) mode. C/S mode needs to install the client software and server software, so this system is used on the fixed machine [15]. A machine that allows students to access the Internet, which is not fixed, can be a computer room, a dormitory, Internet cafes, and so on. Although C/S mode is powerful, having security access and fast network communication, it is not applicable in this study [16] and B/S mode does not need specific client program, it only needs to use the browser. We can request the WEB server via HTTP, which is convenient and flexible, thus it is widely used at present.

The design of the B/S mode finally ascribes to WEB site design. Interuniversity collaborative learning based on network site has three layers of architecture, which are: user layer, application layer, and data service layer. Interuniversity collaborative learning network model is shown in Figure 1. The user uses the WEB browser and sends the request to a WEB server. The server executes the program and returns the corresponding different permissions of the user interface to the user. The application layer is a part of the developers to realize various functions for users. It is located on the server side, and accepts all kinds of requests from the browser, executes program, or performs the operation in connection with the database. Then the results are sent back to the user [17]. This level of platform highlights the use of particular intelligent information. It records the user’s learning process, and reminds learners what to do according to certain rules. The data service layer provides data support for the application layer. It records a large amount of data information such as the learners, teachers, learning process and so on [18]. It is used to query, update, and delete through the interface between database and the application.

![Figure 1: Interuniversity collaborative learning network model](image)

3 Fuzzy comprehensive evaluation for network based interuniversity collaborative learning

Fuzzy comprehensive evaluation adopts fuzzy mathematical theory to obtain quantitative evaluation result in view of the complexity of teaching evaluation object and fuzziness of the evaluation index. The evaluation result has certain objectivity. The process of fuzzy comprehensive evaluation is shown in Figure 2.

Step 1. Set up evaluation factor set

(1) The first level of evaluation factor set \( U = (U_1, U_2, U_3, U_4) \) is set up, which represents initial state, learning attitude, exchange and cooperation, and resource utilization.
(2) Set up the second level of evaluation factor set
\( U_1 = (u_{11}, u_{12}, u_{13}, u_{14}), U_2 = (u_{21}, u_{22}, \ldots, u_{29}), U_3 =
(u_{31}, u_{32}, \ldots, u_{37}), U_4 = (u_{41}, u_{42}, \ldots, u_{46}). \)

Step 2. Determine the evaluation set. \( V = (v_1, v_2, \ldots, v_n), v_I (I = 1, 2, \ldots, n) \) represents all possible evaluation results.

We select five grades as evaluation level of student network learning, which is excellent, good, medium, pass, and fail. The corresponding evaluation sets is \( V = \text{excellent}, \text{good}, \text{medium}, \text{pass}, \text{fail}. \) \( V = \{ v_1, v_2, v_3, v_4, v_5 \}. \) The score of \( v_1 \) is from 90 to 100, the score of \( v_2 \) is from 80 to 90, the score of \( v_3 \) is from 70 to 80, the score of \( v_4 \) is from 60 to 70 and the score of \( v_5 \) is from 0 to 60.

Step 3. Determine weight of evaluation index

Weight is used to measure the role and status of an index in the whole learning evaluation index system. After the indexes are established, we consider its relative importance in the index system. If weight of an index is larger, its value change has large impact on the evaluation results. For different evaluation results, we should scientifically determine the index weight to reasonably carry out the analysis and evaluation. Because, there may be many evaluation indexes, in the selection of index, a kind of attribute reduction method based on difference matrix [19] is adopted to choose the most suitable indexes. The difference matrix is \( m_{ij}. \) \( S = (U, C \cup D, V, f) \) represents the information system decision table, \( U \) represents comment domain, \( V \) represents set of attribute value, \( f : U \times A \to V \) is an information function, \( C \) and \( D \) represents condition attribute and decision attribute respectively.

Firstly, difference matrix of the decision table is worked out. Secondly, the weight value \( w(a_k) \) of each attribute \( a_k \) is calculated. We also work out the number of element containing \( a_k \) in the difference matrix labeled as \( \text{card}(a_k). \) \( R \leftarrow \emptyset, W \leftarrow 0. \) Thirdly, for \( k \) from 1 to \( n \) that represents the number of attribute, if \( w(a_k) > W, W \leftarrow w(a_k). \) If \( w(a_k) = W \) and \( \text{card}(a_k) \) is larger \( W \leftarrow w(a_k). \) Fourthly, \( R \leftarrow R \cup \{ a_k \} \) and the element containing \( a_k \) in the difference matrix is deleted. Fifthly, if the difference matrix is not empty, calculate the each left \( w(a_k) \) and turn to step 3.

Analytic hierarchy process combines the expert’s experience knowledge with mathematical method. When judging matrix is established, the two comparing methods are used, which greatly reduce the uncertainty factors. According to 1 to 9 scale method, index relative important degree value is assigned and comparative value can be obtained. Based on comparative value, judgment matrix can be obtained. If there are \( n \) elements, we obtain a matrix of \( n \times n \) after the two comparing as shown in Table 1.

**Table 1: Comparative table**

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>\cdots</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>(a_{12})</td>
<td>(a_{13})</td>
<td>\cdots</td>
<td>(a_{1n})</td>
</tr>
<tr>
<td>2</td>
<td>(a_{21})</td>
<td>1</td>
<td>(a_{23})</td>
<td>\cdots</td>
<td>(a_{2n})</td>
</tr>
<tr>
<td>3</td>
<td>(a_{31})</td>
<td>(a_{32})</td>
<td>1</td>
<td>\cdots</td>
<td>(a_{3n})</td>
</tr>
<tr>
<td>\cdots</td>
<td>\cdots</td>
<td>\cdots</td>
<td>\cdots</td>
<td>\ddots</td>
<td>\cdots</td>
</tr>
<tr>
<td>n</td>
<td>(a_{n1})</td>
<td>(a_{n2})</td>
<td>(a_{n3})</td>
<td>\cdots</td>
<td>1</td>
</tr>
</tbody>
</table>

Suppose the weight factor vector of evaluation set is \( A = (a_1, a_2, \ldots, a_n), a_i \) represents the weight of evaluation factor \( u_i \) in the total evaluation factor. \( a_i \geq 0, \sum a_i = 1. \) According to the idea of AHP method, we develop the two comparative matrix of network learning behavior evaluation factors by means of expert meeting. The weight of the first level of index is described as follows.

(1) Calculate the sum of each column.
(2) Each item in the matrix is divided by its corresponding column sum, then the standard two comparative matrix is obtained.

(3) Calculate the arithmetic average of each row of the standard two comparative matrix and this average value is called the weight. It is impossible to judge exactly right in the two compared matrices, sometimes there will be error or even contradiction. The higher the judgment order, the more difficult the determination is, and the deviation will increase. In fact, almost all of the two compared matrices have a certain degree of inconsistency. In order to solve the problem of the consistency, the AHP provides a way to measure the degree of consistency. If the degree of consistency cannot meet the requirements, we should review and modify the two compared matrices. Judgment matrix and weight of index in the first level is shown in Table 2.

### Table 2: Judgment matrix and weight of index in the first level

<table>
<thead>
<tr>
<th>U</th>
<th>u_1</th>
<th>u_2</th>
<th>u_3</th>
<th>u_4</th>
<th>a_i</th>
</tr>
</thead>
<tbody>
<tr>
<td>u_1</td>
<td>1</td>
<td>1/3</td>
<td>1/7</td>
<td>1/5</td>
<td>0.057</td>
</tr>
<tr>
<td>u_2</td>
<td>3</td>
<td>1</td>
<td>1/4</td>
<td>1/3</td>
<td>0.131</td>
</tr>
<tr>
<td>u_3</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>0.540</td>
</tr>
<tr>
<td>u_4</td>
<td>5</td>
<td>3</td>
<td>1/3</td>
<td>1</td>
<td>0.272</td>
</tr>
</tbody>
</table>

\[ CI = \frac{\lambda_{max} - n}{n-1} \] is defined as consistency index, \( n \) represents the number of compared index and \( \lambda_{max} \) represents maximum characteristic root of judgment matrix. The weighted vector is \([0.232, 0.528, 2.279, 1.130]\). \( \lambda_{max} = (0.232/0.057 + 0.528/0.131 + 2.279/0.540 + 1.130/0.272)/4 = 4.119 \)

\[ CR = 0.044 < 0.1 \] means that judgment matrix has the characteristic of consistency and the weight is reasonable. The second level of index and corresponding weight is worked out in the same way. 16 teachers evaluate one student comprehensively, the obtained survey statistics is shown in Table 3.

- \( u_{31} \) represents whether the learners current level has the condition for acquiring new learning content. \( u_{12} \) represents whether the learners can adapt to study under interuniversity collaborative learning. \( u_{13} \) represents learning condition of the learner. \( u_{14} \) represents learning motivation. \( u_{21} \) represents the case whether a student can complete learning task according to curriculum plane. \( u_{22} \) represents the case in which a student takes part in network teaching activities actively. \( u_{23} \) represents the case in which a students is likely to interact with other partners. \( u_{24} \) represents the case in which a students can complete some challenging tasks. \( u_{25} \) represents the autonomous learning ability. \( u_{26} \) represents the autonomous learning note. \( u_{27} \) represents a student, who can take part in the necessary tutorial. \( u_{28} \) represents a student, who can timely submit course assignments. \( u_{29} \) represents the case in which a student has been cheating. \( u_{31} \) represents the case in which a student usually asks a teacher. \( u_{32} \) represents the case in which a student often announces opinion corresponding to curriculum in the discussion area. \( u_{33} \) represents the case in which a student can extract useful information from others opinion. \( u_{34} \) represents the case in which a student often talk questions with teachers or students. \( u_{35} \) represents the case in which a student propose constructive advice for teacher’s work. \( u_{36} \) represents the case in which a student can answer the questions timely. \( u_{37} \) represents the case in which a student can complete subject with other actively learning partners. \( u_{41} \)

| Table 3: The survey statistics table of interuniversity collaborative learning evaluation |
|---------------------------------|-----------------|-----------------|-----------------|
|                                | the first level | weight          | the second level | weight          | Evaluation level |
|                                |                 |                 |                 |                 |                 |
| u_1                            |                 |                 |                 |                 |                 |
| 0.057                          | u_11            | 0.548           | 3               | 6               | 4               | 2               | 1               |
|                                |                 |                 |                 |                 |                 |                 |                 |
| u_2                            |                 |                 |                 |                 |                 |                 |                 |
| 0.313                          | u_21            | 0.177           | 3               | 6               | 3               | 2               | 2               |
|                                |                 |                 |                 |                 |                 |                 |                 |
| u_3                            |                 |                 |                 |                 |                 |                 |                 |
| 0.540                          | u_31            | 0.246           | 4               | 5               | 6               | 1               | 0               |
|                                |                 |                 |                 |                 |                 |                 |                 |
| u_4                            |                 |                 |                 |                 |                 |                 |                 |
| 0.272                          | u_41            | 0.037           | 0               | 2               | 4               | 6               | 4               |
|                                |                 |                 |                 |                 |                 |                 |                 |
|                                |                 |                 |                 |                 |                 |                 |                 |

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represents the case in which a student uploads valuable resource on the system platform. \( u_{42} \) represents the case in which a student queries information in the resource library. \( u_{43} \) represents the case in which a student often makes notes. \( u_{44} \) represents the case in which a student can choose all kinds of resources to study. \( u_{45} \) represents the case in which a student has strong information ability. \( u_{46} \) represents the case in which a student can use his knowledge to solve actual problem.

![Figure 3: Process of network based interuniversity collaborative learning evaluation](image)

Process of network based interuniversity collaborative learning evaluation is shown in Figure 3. According to Table 3, we can obtain fuzzy evaluation matrix of the second level of index, \( R_{1}^{(2)} \), \( R_{2}^{(2)} \), \( R_{3}^{(2)} \) and \( R_{4}^{(2)} \). According to fuzzy evaluation matrix \( R_{i}^{(2)} \), we work out the comprehensive evaluation result set for each factor in the second level of index.

\[
A_{i}^{(2)} = (W_{i}^{(2)})^T \cdot R_{i}^{(2)}
\]

After normalization, \( A^{(1)} = (0.149, 0.342, 0.282, 0.159, 0.068) \). Then weighted average method is used to determine the comprehensive evaluation results. We need to assign level parameter to each evaluation level, and then level parameter matrix is obtained. The fuzzy comprehensive evaluation result is \( S = A^{(1)} \cdot V^T \). \( V = (90, 80, 70, 60, 50) \). \( S = A^{(1)} \cdot V^T = (0.149, 0.342, 0.282, 0.159, 0.068) \cdot V^T = 73 \).

### 4 Conclusion

Highly developed modern education technology and widely applied modern information technology made education via internet an important teaching method and teaching system. Interuniversity collaborative learning based on network as a new type mode of network education, and its evaluation is paid more and more attention. There are few researches in evaluation of interuniversity collaborative learning based on network. Most of them neglect personality of collaborative learning; and they do not form an integrated index system, the evaluation is not scientific and all-round. Resolving these problems is a long time research. A reasonable evaluation method of interuniversity collaborative learning based on network is put forward, which includes process’s evaluation, result’s evaluation, quantitative evaluation and qualitative evaluation. It is able to provide a new thought for interuniversity collaborative learning evaluation based on network.

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**References**


