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Construction and Research on the Evaluation System of University Curriculum Teaching Quality Based on Analytic Hierarchy Process

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Abstract: The analysis of big data in education to further promote smart education, construct a high-quality education support system, and promote the sustained and healthy development of "Internet+ education", is one of the hot issues in the academic circle at present. In this study, the course teaching of North China University of Water Resources and Electric Power was taken as the research object firstly. Then, the indicators at all levels of teaching evaluation were determined based on the analytic hierarchy process, the comprehensive weight of each indicator was calculated. Next, the university curriculum teaching quality evaluation system based on big data was constructed, and the results show that the influence of the first-layer indicators on teaching evaluation is in the order of knowledge evaluation > behavior evaluation > experience evaluation; the comprehensive weight value of final test is 0.3809, which indicates the proportion of judging the teaching effect of teachers solely by students' performance has gradually declined in the information-based classroom teaching; the comprehensive weight value of Homework reached 0.2097, further indicating that teaching evaluation was paying more and more attention to the process assessment results. Therefore, teachers should give full play to students' main role, establish an indicator system more comprehensively, so as to build a scientific, reasonable and personalized evaluation system of university curriculum teaching quality more pertinently.

1. Introduction

To build a strong country through education is the basic project for the great rejuvenation of the Chinese nation. In January 2022, the State Council issued the "14th Five-Year Plan" for Digital Economic Development, which proposes to further promote smart education, construct a high-quality

education support system, and promote the sustained and healthy development of “Internet+ education” [1]. In February 2022, the Ministry of Education issued the Key Work Points of the Ministry of Education in 2022, which points out that one of the main work points this year is to implement the strategic action of education digitization [2], improve classroom teaching mode and evaluation method, strengthen data mining and analysis, and deepen the integration and innovation of information technology and education and teaching.

The analysis of big data in education is one of the hot issues in the academic circle at present [3]. More and more educators begin to pay attention to the application value of big data in the reform and development of higher education and teaching [4, 5]. Specifically, the intervention of big data has enriched the function of education evaluation, expanded and deepened the connotation of education and teaching itself, and gradually became an important technical force to promote the development of higher education [6, 7]. First of all, big data means to collect education data in an all-round way, truly reflect the students' state and problems in the learning process, and support the teaching process is more accurate and feasible [8]. Secondly, teaching evaluation based on big data breaks through the dependence on students’ test scores in the traditional education evaluation system, integrates fragmented evaluation into systematic evaluation, supports multi-subject and diversified evaluation methods, ensures the comprehensiveness and sustainability of evaluation, and enriches the function of education evaluation [9]. Finally, big data for education provides reliable information and empirical evidence for schools, majors and teachers to make accurate teaching evaluation [10].

The analytic hierarchy process (AHP) is a systematic analysis method proposed by professor T.L. Saaty of the United States in the 1970s to make decisions on complex and fuzzy problems [11, 12]. It is characterized in that the decision thinking process of the decision maker is mathematically processed with less quantitative information on the basis of in-depth analysis of the essence, influencing factors and internal relations of the complex decision problems, thereby providing a simple decision means for the complex decision problems [13, 14]. Xie Jian et al. constructed the teaching ability evaluation indicator system of university teachers from both qualitative and quantitative aspects based on analytic hierarchy process, and effectively evaluated the teaching ability level of university teachers [15]. Wang Yajie established the evaluation system of network-enhanced course teaching by analytic hierarchy process, fully adopted the quantitative description of pairwise importance comparison of evaluation indicators by evaluation subjects, calculated the weight assignment of indicators, and achieved good results [16].

In this paper, the course teaching of North China University of Water Resources and Electric Power was taken as the research object, and a more comprehensive big data collection and analysis system was built, which deeply integrated information technology with major teaching, management and service, and used new technical forms, data forms, organizational forms and relationship forms to reshape the traditional university classroom teaching. Analytic hierarchy process (AHP) was used to effectively analyze teaching big data, which promoted the proceduring of course assessment, the quantification of process data, the refinement of teaching evaluation and the digitization of teaching decision, constantly pushed the analysis of educational big data from “paper” to “practice”, and gradually realized the informatization of higher education in China.

2. Construction of the Evaluation System

A teaching evaluation system based on big data in colleges and universities was established, which is a teaching evaluation system of “NCWU Cloud Classroom” developed on the platform of WeChat, including three evaluation elements: knowledge evaluation, behavior evaluation and experience evaluation (Figure. 1).

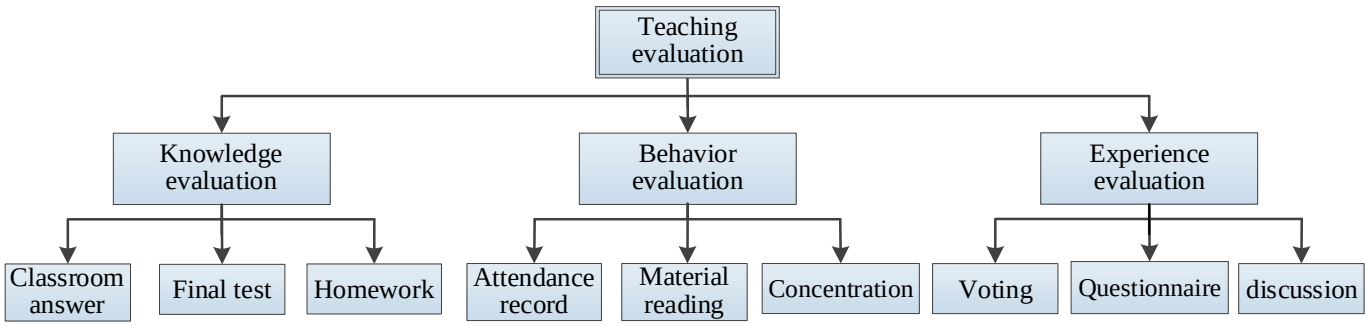

Figure 1: The Construction of Evaluation System.

2.1. Knowledge Evaluation

Knowledge evaluation can effectively express students' mastery of knowledge. It is mainly composed of three modules: classroom answer, final test and homework.

1) Classroom answer. As one of the core functions of "NCWU Cloud Classroom", it is designed to collect students' answer data in time with teachers' questions in class, and transmit the results to teachers, so that teachers can keep abreast of students' mastery of knowledge points, keep track of the course progress at any time, and be more effective and targeted.

2) Final test. Varied greatly from the classroom answer function which has no questions on the mobile, it can present test questions by assisting teachers via PPT or by other means in class. For the final test, the teacher works out the questions and answers in the system in advance and opens them to the students to answer in time. The final test includes two modules: the main function of test and the question bank.

3) Homework. It carries a wealth of questions, such as short answer questions, essay questions, discussion questions, etc. Students can edit the text, take pictures to upload, voice response and answer in other ways, in order to meet the needs of different homework.

2.2. Behavior Evaluation

The "behavior evaluation" expresses the students' positive degree of knowledge learning behavior, which mainly consists of three modules: attendance record, material reading and concentration.

1) Attendance record. As one of the core functions of "NCWU Cloud Classroom", it is characterized by fast sign-in speed, accurate record, and can effectively improve the roll call speed, reduce the roll call time and increase the effective teaching time in class.

2) Material reading. It can upload rich teaching resources to the system, effectively assist teachers to expand their knowledge before and after class, and evaluate students' reading situation through their watching time and interaction.

3) Concentration. Among them, "concentration" is automatically counted by the system, which mainly records the time when students don't use their mobile phones according to regulations, the response time when they are required to use them, etc.

2.3. Experience Evaluation

"Experience evaluation" expresses the degree of students' participation in the process of teacher-student interaction. It is mainly composed of three modules: voting, questionnaire and discussion.

The three modules of voting, questionnaire and discussion are important functions established at the request of the majority of teachers. They not only exist in each class, but also have special shortcut

buttons on the front page to facilitate teachers who have not established courses but need to collect information to quickly establish voting, questionnaire and discussion. The voting and questionnaire includes two modules: the main function of the voting questionnaire and the question bank that is independent from the curriculum. Every teacher can set up a question bank on his/her mobile phone, which will not disappear because of the end or deletion of a course, for publishing, editing and modifying voting and questionnaire in each course. The updated question bank is available for use in all of the teacher's classes and in the Questionnaire feature of the main interface. This arrangement ensures that the voting and questionnaire can be used repeatedly in different classes and can be released differently.

3. Weight of Big Data Classroom Teaching Evaluation Indicators Based on Analytic Hierarchy Process

In this paper, the analytic hierarchy process (AHP) was used to calculate the indicator weight, including determining the analytic hierarchy process, establishing the comparison matrix, calculating the weight value and checking the consistency.

3.1. Determination of the Analytic Hierarchy Process

According to the analytic hierarchy process, the scoring indicators were determined and a hierarchical structural model was created, wherein the first layer is a target layer: teaching evaluation (A). The three evaluation dimensions of knowledge evaluation (B1), behavior evaluation (B2), and experience evaluation (B3) were taken as the evaluation criteria of the middle level. According to the feedback from experts, supervisors and first-line teachers, and in combination with the classroom process data collected by the analysis system, the indicator system of the third layer of plan layer was formulated, including nine indicators in total (Figure 1) of classroom answer (C1), final test (C2), homework (C3), attendance record (C4), material reading (C5), concentration (C6), voting (C7), questionnaire (C8) and discussion (C9).

3.2. Establishing the Comparison Matrix

Since the importance of each evaluation indicator in the hierarchical structure is not necessarily the same in the target measurement, it is necessary to construct a judgment matrix of pairwise comparison to quantify the subjective evaluation results and rank the importance of the indexes (Table 1).

Table 1: Evaluation scale of analytic hierarchy process.

Factor i versus factor j	Quantized value
Equally important	1
Slightly important	3
Relatively important	5
More important	7
Extremely important	9
The median value of adjacent judgments	2,4,6,8

3.3. Calculating the Weight Value and Consistency Check

Based on the data collected by the system, a judgment matrix from target layer A to criterion layer B was constructed to get the weights of each evaluation dimension of layer B relative to layer A.

Based on the data collected by teachers and questionnaires in class, the judgment matrix from criterion layer B to index layer C was constructed to get the weights of each evaluation indicator in layer C relative to layer B.

As pairwise comparison judgment matrix is the quantification of subjective evaluation of evaluation subject, consistency test of comparison judgment matrix was needed to avoid the unreliable results. To test whether the weight coefficient of the judgment matrix is reasonable, the value of CI (consistency indicator) must be calculated by the formula:

$$CI = \frac{\lambda_{max-n}}{n-1} \quad (1)$$

CI=0 indicates that the judgment matrices were completely consistent. The greater CI is, the more serious the inconsistency of the judgment matrices is.

Then, the corresponding RI (random consistency index) value was found according to the n value, and the consistency ratio CR was calculated by the formula:

$$CR = \frac{CI}{RI} \quad (2)$$

The indicator of each layer CR < 0.1 can determine that the matrix met the condition of consistency and passed the consistency test; If CR ≥ 0.1, the judgment matrix should be appropriately modified until it passed the consistency test.

4. Calculating the Indicator Weight by Analytic Hierarchy Process

4.1. Constructing a Pairwise Comparison Judgment Matrix Based on Big Data Analysis

In this teaching evaluation and analysis, the curriculum process data of 123 students in 12 courses were collected by using the "NCWU Cloud Classroom" system, and 45 teachers and 12 supervisors were surveyed by questionnaire, and 55 valid questionnaires were collected. At the same time, an anonymous questionnaire survey was conducted among the students majoring in geography to count the importance of each evaluation indicator, and a total of 286 valid questionnaires were collected. The relative importance of pairwise comparison of elements in this paper was valued according to the mode principle. If the same mode occurs, it was valued according to the median. The following comparative judgment matrices (Tables 2-5) were constructed by sorting out the valid questionnaires:

Table 2: Judgment matrix of classroom teaching evaluation on the overall goal based on big data.

Teaching evaluation A	Knowledge evaluation(B1)	Behavior evaluation(B2)	Experience evaluation(B3)
Knowledge evaluation(B1)	1	3	5
Behavior evaluation(B2)	1/3	1	2
Experience evaluation(B3)	1/5	1/2	1

Table 3: Judgment matrix of knowledge evaluation.

Knowledge evaluation(B1)	Classroom answer(C1)	Final test(C2)	Homework(C3)
Classroom answer(C1)	1	1/4	1/5
Final test(C2)	6	1	2
Homework(C3)	4	1/2	1

Table 4: Judgment matrix of behavior evaluation

Behavior Evaluation(B2)	Attendance record(C4)	Material reading(C5)	Concentration(C6)
Attendance record(C4)	1	1/2	1/3
Material reading(C5)	2	1	1/2
Concentration(C6)	3	2	1

Table 5: Judgment matrix of experience evaluation

Experience evaluation(B3)	Voting(C7)	Questionnaire(C8)	Discussion(C9)
Voting(C7)	1	1/2	1/4
Questionnaire(C8)	2	1	1/3
Discussion(C9)	4	3	1

4.2. Consistency Check

The consistency test results were obtained by building a hierarchical structure model and inputting judgment matrix in turn. The λmax of each matrix in Tables 2-5 was 3.004, 3.009, 3.009, and 3.018, and the CR values were 0.004, 0.009, 0.009, and 0.017, respectively. The results showed that each judgment matrix CR<0.1, and all of them passed the consistency check.

4.3. Weights of Each Layer and Comprehensive Weight

The weights of the indicators in each layer were calculated according to the analytic hierarchy process, and the comprehensive weights of each indicator in the scheme layer were calculated by multiplying the weights of the first layer indicators by the weights of the second layer indicators.

Table 6: Weight and comprehensive weight of indicators at all layers.

First-layer indicators	Weight	Scheme-layer	Weight	Comprehensive weight
Knowledge evaluation (B1)	0.6483	Classroom answer (C1)	0.0890	0.0577
		Final test (C2)	0.5876	0.3809
		Homework (C3)	0.3234	0.2097
Behavior evaluation (B2)	0.2297	Attendance record (C4)	0.1634	0.0375
		Material reading (C5)	0.2970	0.0682
		Concentration (C6)	0.5396	0.1239
Experience evaluation (B3)	0.1220	Voting (C7)	0.1365	0.0167
		Questionnaire (C8)	0.2385	0.0291
		Discussion (C9)	0.6250	0.0763

Table 6 shows that the influence of the first-layer indicators on teaching evaluation is in the order of B1>B2>B3, with knowledge evaluation ranking first. Among the three scheme-layer indicators ranking under this indicator, the weight of final test C2 has the greatest impact on knowledge evaluation, which indicates that the result of final test is still the primary factor for judging the students' knowledge mastery. At the same time, the comprehensive weight value of 0.3809 also indicates that the proportion of judging the teaching effect of teachers solely by students' performance has gradually declined in the information-based classroom teaching nowadays, and the teaching evaluation for college teachers is becoming diversified.

The comprehensive weight of homework C3 in the scheme layer ranked second among the nine two-level indicators, indicating that the classroom teaching evaluation based on big data was still strongly affected by the traditional teaching evaluation and had a high degree of dependence on the test results. However, compared with the weight value of C2 of 0.3809, the comprehensive weight

value of C3 also reached 0.2097, further indicating that teaching evaluation was paying more and more attention to the process assessment results. The third in comprehensive weight is concentration C6, which is the length of time that students do not use mobile phones in class that is automatically counted by the system. It fully shows that the impact of mobile phones on teaching effect has become the consensus of teachers, supervisors and students. It also reflects indirectly that students do not effectively focus on knowledge learning in class, which may be due to the lack of teachers' professional ability, the unattractive course description, and students' habitual mind-wandering. Therefore, the categories of attentiveness should be further subdivided in the division of the two-level indicators, so as to evaluate the reasons for the insufficient attentiveness in a more targeted manner.

The comprehensive weight values of the other six indicators at the scheme layer were less than 0.1, which indicates that the overall impact on teaching evaluation is limited, and the impact of the course teaching process factors on the teaching effect still needs to be further improved.

5. Conclusion

In summary, it is of great significance to use analytic hierarchy process (AHP) to assign evaluation indicators to construct the evaluation system of university curriculum teaching effect based on big data. The above analysis shows that the richness and comprehensive weight of all levels of indicators in the evaluation system have a great impact on the evaluation of the actual teaching effect. Therefore, teachers should give full play to students' main role, establish an indicator system more comprehensively, pay more attention to the process data and constantly adjust the weights and parameters with the support of the Internet and system, so as to build a scientific, reasonable and personalized evaluation system of university curriculum teaching quality more pertinently.

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