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Research Article

Investigation and Analysis of Classroom Teaching Quality in Universities in an Interval Intuitionistic Fuzzy Environment

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In recent years, China's economic strength has been developing rapidly. At the same time, people's daily living standards have also been increasingly rising. In this context, the authorities are paying more and more attention to the training of students as well as talents. As a result, the quality of classroom teaching in universities has become a major concern. As an essential evaluation tool for teaching quality, evaluation of classroom teaching has been widely recognised and implemented. With the rapid development of computer technology and information technology, teaching evaluation based on various algorithms has been widely used, thus becoming an increasingly important teaching evaluation method. Thus, classroom teaching assessment has become one of the hot issues discussed in the field of education both at home and abroad. A great number of universities are now fully aware that the effectiveness of teachers is central to their survival and development and can have a direct impact on the training of students. The criteria for evaluating the effectiveness of teaching are highly subjective, but at the same time, there is a considerable degree of objectivity. As a result, the application of more scientific methods and computational data can make the results of classroom assessment more reliable. However, there is a lack of reliable reference data for evaluating the quality of classroom teaching in higher education. In addition, it is difficult to develop an evaluation data management and evaluation management model based on multiple data sources, which may cause a negative effect on the impartiality and objectivity of evaluation results. What is worse, many teachers do not have enough time to interact with their students. After all, most teachers in universities now have a heavy teaching load, and much of their time is spent on lesson preparation. Hence, they usually lack active interaction with their students. In the current education system, the objectives of higher education are mainly test-taking, and practical application is lacking. Therefore, based on the existing teaching basis, how to improve the effectiveness of university classroom teaching and improve the overall quality of students on the basis of test-taking objectives will be a key issue in teaching research. In order to solve this problem, this paper mainly researches the evaluation of classroom teaching quality in universities based on the interval intuitionistic fuzzy theory. This study is based on a detailed analysis of the needs of teaching quality assessment management, in terms of comprehensiveness of assessment and data sources. Then, the teaching evaluation system is designed and developed based on an analysis of the roles of students and teachers. This system can be applied to speed up the efficiency and fairness of teaching evaluation in universities, thereby greatly improving the management of teaching in universities.

1. Introduction

In recent years, people's quality of life has become better and better, driven by China's rapid economic development. Against this backdrop, the education of children has become increasingly important to the government and the people [1]. As an essential vehicle for training the future talents of our country, schools carry the dream of a strong country and the high hopes of parents [2]. In the development of schools, the quality of teaching and learning is a direct measure of the quality of the school. To be specific, it can reflect the reputation of the school and has a direct impact on the future of the students [3]. As a result, how to strengthen the management of teaching quality and gradually improve the quality of the teaching team and the level of teaching is the key to cultivating high quality talents in the new century. In the management of teaching, the evaluation of teachers' quality is an essential means of improving teaching quality

and is the core of teaching management [4]. There is a growing consensus that schools are only as excellent as the students they produce. As a result, many scholars have begun to study and develop measures to improve the quality of teaching and learning, with the aim of maintaining order and improving the quality of teaching and learning [5, 6]. As the scale of education continues to expand and the number of students increases, the quality of teaching and learning becomes an increasing concern for society. The quality of education is crucial to the survival and development of the school and is the centrepiece and constant theme of all schoolwork [7].

However, there are still many problems with the existing university teaching quality evaluation system in China. Although many universities have discussed the effectiveness of classroom teaching, the question of how to build a fair and objective teaching evaluation system is still an essential issue for most universities [8]. To be specific, the following problems exist in the existing system for evaluating the quality of classroom teaching. First and foremost, the evaluation indicators fail to reflect the characteristics of each evaluator and therefore make it difficult to realistically reflect the standard of the subject of the evaluation [9]. In the actual evaluation of teaching and learning, most methods focus only on the behaviour and measurability of indicators [10]. However, many indicators and factors cannot be studied quantitatively and are therefore often neglected. Effectiveness evaluation, on the other hand, usually treats some specific indicators as value orientations, and the process is only concerned with whether the indicators are achieved or not [11]. Therefore, such systems can directly lead to evaluation results that make it difficult to reasonably identify the standard of the evaluated object. Second, most systems for evaluating the quality of teaching are fixed and hardly serve as an incentive. Nowadays, most universities have developed a fixed system of relevant teaching evaluation indicators based on the actual situation. For the evaluation of teaching, whether professor, lecturer, or assistant teacher, similar evaluation criteria are applied [12]. This phenomenon leads to a vague selection of indicators for the evaluation of teaching. As a result, the rigidity of the indicators makes it difficult to evaluate the effectiveness of teaching in a way that stimulates and enhances it [13]. In addition, in most universities, teaching quality is still assessed adopting traditional paper-based approaches, which can lead to some drawbacks such as low effectiveness. This paper-based approach to evaluation makes it a tricky project [14]. It can be time-consuming and inefficient, seriously affecting the efficiency of the school and ultimately leading to a formal evaluation of teaching and learning that does not improve outcomes. Therefore, it is necessary to design an excellent teaching evaluation system in order to strengthen the management of teaching quality and to better improve the quality of education in universities.

At present, many universities' teaching quality evaluation systems are based on student grades and practical activities as the core data [15]. Generally speaking, the evaluation indicators for practical activities are the same for all students, so the evaluation of teaching quality is based on students' performance in school. However, this approach cannot truly characterise the quality of teaching and learning [16]. The evaluation data are entered directly by the class tutor and do not go through the online evaluation and scoring process. As a result, the final results of the evaluation are often contested as criteria for teacher evaluation and selection and fail to reflect the principles of fairness and objectivity [17]. It is clear that the assessment of teaching quality is not the kind of assessment that is entered at the end of the semester but rather a dynamic way of managing the performance of teachers and student counselling during the school year [18]. The evaluation process is cumbersome, and the indicators are therefore vague. Generally, at the end of the semester, each academic department will give a token comment as a conclusion to the evaluation of teaching quality [19]. This model is not conducive to a comprehensive evaluation of teaching quality and is not based on a fixed standard, let alone a mature evaluation system. As a result, it becomes formalised and does not constitute a comprehensive evaluation system based on information-based indicators [20]. At present, there is no recognised evaluation system for the quality of teaching in our schools. In addition to the main evaluation, the evaluation criteria for teaching quality should consist of other evaluations, self-evaluations, and comprehensive evaluations of various kinds [21]. This is the only way to better reflect the comprehensive evaluation of teaching quality and to measure and evaluate the quality of a teacher's teaching in a comprehensive manner.

Although some universities have developed software that can be used to evaluate the quality of teaching, these software systems are generally limited to a particular department, such as the Academic Affairs Office, which mainly evaluates the quality of teaching through student performance [22]. To a certain extent, these software systems can be used to evaluate the quality of teaching and provide decision support for teaching quality management. However, the data cannot be shared across departments. If other departments need to know these data, they can only do so by asking the Academic Affairs Office or obtaining the relevant reports [23]. As a result, there is a lack of information and high communication costs between departments, which is not in line with the current requirement for data sharing between the relevant departments of the university. In recent years, the rapid development of computer technology has brought significant development to the information construction of universities. Many computer technologies such as machine learning [24, 25], deep learning [26, 27], and life-cycle assessment [28, 29] have been fully developed. The rapid advances in technology have led to a gradual reduction in the cost of information in universities. A number of universities have implemented digital university systems that enable comprehensive management of all aspects of student registration, student work management and teaching and learning assessment management. These systems can provide a complete set of solutions for the normal teaching and research operations of universities. At the same time, each department can complete the operation of the corresponding modules through the assigned user roles. The application of the system can improve the competitiveness of

the university and thus improve the efficiency of the university management.

With the strengthening of teaching evaluation management in overseas universities, more and more university administrators have gained a deeper and more comprehensive understanding of teaching evaluation management [30]. In terms of information systems, they are no longer limited to the management of basic information on teaching and learning assessment. Instead, these systems are designed to meet the needs of the various teaching and evaluation departments in universities and to provide a software platform for teaching and evaluation management in the current context. The management of teaching evaluation in higher education is a dynamic process that will continue to improve as the management mechanisms of higher education change [31]. In particular, with the application of new technologies, such as mobile Internet and mobile phone clients, the original B/S-based system has evolved into a richer and more comprehensive platform. The use of mobile phones for teaching evaluation management is becoming more and more common, changing the way it is managed and thus allowing for flexibility in the office. At present, teaching evaluation offices in universities have corresponding teaching evaluation management systems, which cover all aspects of teaching evaluation management, including teaching evaluation information management, course management, and other process management.

The development of the teaching evaluation system in this paper is based on research of the design models and ideas of excellent teaching systems at home and abroad. The system proposed in this study is designed and developed with the advantages of other systems, and the shortcomings of other systems are avoided, making the system more suitable for the task of teaching evaluation in schools. By developing a teaching evaluation system based on interval intuition fuzzy theory, this research provides a suitable teaching management platform for universities to meet the functional requirements of teaching evaluation and improve the quality of teaching in universities.

2. Technology Related to Evaluation of Teaching Quality

2.1. Net Platform. The .Net platform is a complete application development solution based on a component-based approach. Although the development languages applied are divergent, the base class libraries are the same. To be specific, applications developed in each language can call on a common library of components to implement the underlying functionality. In this case, the .Net platform-based applications therefore have the advantage of sharing data and technical frameworks. By using the .Net platform for development, the technical staff involved can significantly shorten the development cycle and reuse different components, thus increasing the efficiency of system design and development.

The .Net platform defines a set of enterprise-level standards for application development. This standard allows technicians to quickly develop applications in their own programming language. In other words, the .Net framework enables the classic layering of data, business, and functionality, which can greatly improve the ease of operation and scalability of later systems. For example, when the business changes, the logic definition of the business layer can be modified. In this case, when the system database platform is changed, only the data interface needs to be adjusted in the data layer. If the layout of the operating pages needs to be adjusted in the final functional layer, the programmer only needs to make changes to the functional layout, not the business logic or the data access interface.

Therefore, the .Net platform can provide a complete solution for application development in all business areas. Figure 1 shows the basic framework of the .Net platform. The .Net database can access interface uses data access interfaces, including ADO, ODBC, and so on. These database drivers are installed during initialisation and can be upgraded from the relevant website. In addition to the computer's own database drivers, the .Net platform also supports other types of database drivers, such as Oracle, MySQL, and so on.

2.2. UML. UML is a unified modelling language that graphically models the analysis and design phases of a software system, using object-oriented design thinking. In the analysis phase of a software system, after the analysis of the system requirements has been completed, the functional analysis of the system needs to be completed using UML. In general, the functional analysis of a system should be done in terms of a functional model, a static model and a dynamic model, which are shown in Figure 2. The functional model is described by a use case diagram, which includes the participants, the use cases, and the relationships between the use cases. In the use case diagram, the participants are the final users of the system and the use cases represent the operational functions. In addition to this, functions include primary and secondary functions. The static model of the system is represented by the entity class diagram of the system, which does not include the methods of the class but only the properties of the class. The dynamic model is described by the activity diagram, which is a sequential, selection, and juxtaposition structure to complete the operation of a use case.

In the design phase of a software system, class diagrams and sequence diagrams are adopted to design the functionality of the system. The class diagram is designed within the entity class diagram in the system analysis phase and allows for further expansion and design of the solution space. Sequence diagrams are used to represent the timing of calls between classes in the design of a function. In the design phase, algorithms or operations with complex state changes can be described by means of state diagrams. For large applications or integrated applications, a package diagram can be used to describe the composition of the packages. To be specific, a unit function can be designed as a package, which can include several classes or interfaces. In summary, the deployment of a software system can be described by means of component diagrams during the programming implementation

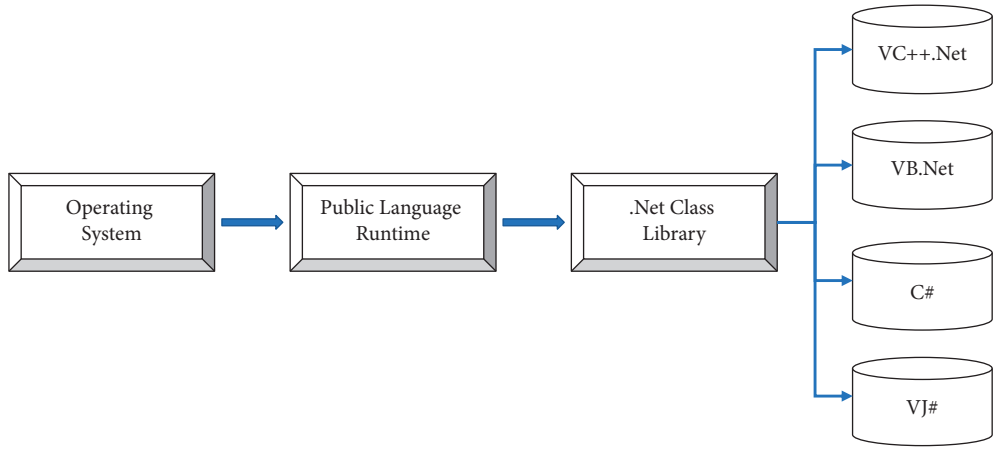

Figure 1: Basic framework of the.Net platform.

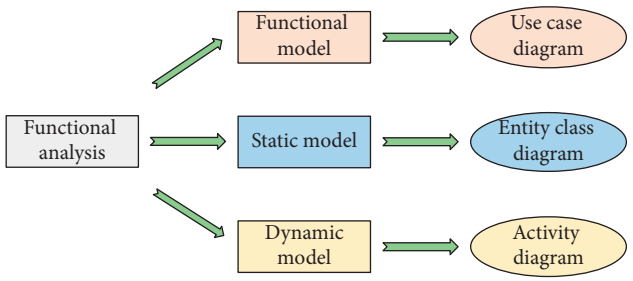

Figure 2: Functional analysis of a system.

phase. During the programming implementation, the implementation process of the system can also be described through activity diagrams and for some core algorithms can be described through sequence diagrams and activity diagrams.

2.3. Interval Intuitionistic Fuzzy Theory. Based on the research of fuzzy theory, interval intuitionistic fuzzy theory has been widely studied by scholars at home and abroad and has been applied to many fields such as multiattribute decision-making, pattern recognition, and data mining. Similarity measures are an important information tool in interval intuitionistic fuzzy theory, aiming to measure the closeness of different interval intuitionistic fuzzy sets to each other. In addition, similarity measures play a decisive role in fuzzy pattern recognition. Therefore, it is of great interest to find a reasonable and effective similarity measure for interval intuitionistic fuzzy sets. At present, a great number of scholars have conducted a lot of research on the similarity measures of interval intuitionistic fuzzy sets. However, it is found that most of the similarity measures of intuitionistic fuzzy sets do not satisfy the axioms of similarity measures. Although the similarity measure of interval intuitionistic fuzzy sets satisfies the similarity measure axiom, the method is more complicated. The detailed steps are shown as follows:

2.3.1. Determine Set of Evaluation Factors. The set of evaluation factors is a set of evaluation factors of the subject to be evaluated as elements. The set of evaluation factors is generally based on the characteristics of the subject to be evaluated and the evaluation criteria known from the needs analysis. In this study, the set of evaluation factors is divided into two levels of evaluation indicators. Thus, the first-level evaluation indicators' set can be obtained as

$$F = \{F_1, F_2, \ldots, F_n\}, \tag{1}$$

where F refers to the evaluation indicator.

Next, the first-level evaluation indicators can be subdivided, so that the second-level evaluation indicators can be identified:

$$F_n = \{F_{n1}, F_{n2}, \ldots, F_{nm}\}. \tag{2}$$

In the teaching evaluation system, the first-level evaluation indicators are divided into four areas: preparation, lectures, assignments, and education. Each first-level indicator can be divided into the second-level indicators. The specific division criteria are shown in Table 1.

2.3.2. Determine Judging Set. After determining the set of evaluation factors, the judging set can be determined as follows:

$$J = \{J_1, J_2, \ldots, J_k\}, \tag{3}$$

where J refers to the judging set, and each level can be compared to a fuzzy subset.

2.3.3. Determine Weight of Evaluation Indicator. Based on the statistical analysis of the evaluation factors, the weight vectors for each evaluation factor were obtained as shown in Table 2. The weight table corresponds to the evaluation factor in Table 1, respectively.

2.3.4. Determine Affiliation of Evaluation Indicator. For each evaluation factor in the set of evaluation factors, its affiliation can be determined from the data collected from the students' evaluations. The fuzzy matrix can be obtained by putting all the students' evaluations into a matrix.

Table 1: Specific division criteria.

First-level indicator	Second-level indicator
Preparation	Well prepared for teaching
	Teaching content enrichment
Lecture	Enlightenment
	Important and difficult points
Assignment	Attitude
	Timeliness
Education	Work ethic
	Caring

Table 2: Weight of each evaluation indicator.

First-level indicator	Second-level indicator
Preparation (0.2)	Well prepared for teaching (0.1)
	Teaching content enrichment (0.1)
Lecture (0.4)	Enlightenment (0.2)
	Important and difficult points (0.2)
Assignment (0.3)	Attitude (0.15)
	Timeliness (0.15)
Education (0.1)	Work ethic (0.05)
	Caring (0.05)

$$\mathrm{FM} = \begin{bmatrix} F_{11} & \cdots & F_{15} \\ \vdots & \ddots & \vdots \\ F_{n1} & \cdots & F_{n5} \end{bmatrix}, \tag{4}$$

where F_{ij} refers to the affiliation of each evaluation indicator.

2.3.5. Determine Fuzzy Operator. The weighting of the evaluation factors identified in the teaching evaluation system is even. There are no situations where one weight dominates over another, so the weighted average method is chosen. This method is more effective in cases where the weights of the evaluation factors are not dominant and considers the weights of all evaluation factors, so that the results reflect the effects of all evaluation factors.

3. Teaching Quality Evaluation System

As the evaluation of teacher teaching quality is a comprehensive exercise, it is necessary to use sources of evaluation such as supervision data from the Academic Office. This approach makes the evaluation results more impartial and objective. In addition, the evaluation of teaching quality is often subject to changes in the priorities of the school and faculty from year to year and from semester to semester. As a result, the weighting of each factor can be used to calculate the final overall grade, which can be adjusted by the academic staff and the staff concerned.

3.1. Function Analysis. As the system is designed to evaluate teachers, teacher information needs to be managed. In addition to basic teacher information, this includes information about majors and classes. As a result, the maintenance of basic information also includes the management of majors, classes as well as teachers' information. This can be achieved through data entry and bulk import by the Academic Affairs Office. The basic data management use case diagram can be obtained as shown in Figure 3.

The teacher information addition activity diagram is shown in Figure 4. In the classroom quality assessment system, the objects involved include the Registrar's Office, the system, and the data processing object. The data processing object is used to complete database operations. Specifically, the Registrar's Office first logs into the system and enters the teacher information registration page. You will then need to select the course and class that the teacher is teaching and enter the teacher's job number. Once entered, the system will check the teacher's work number to determine if the teacher exists. If it is a duplicate of a record in the database, the teacher will be prompted. Conversely, if the teacher's work number is not duplicated, the Registrar will complete the entry of the other information. Once the entry is complete, the data are saved to the database by performing a save operation and the system indicates that the save is complete.

3.2. Selection of System Model. As software systems continue to improve in functionality and scale, the choice of system architecture becomes the most important factor in constraining system performance. The architectural requirements of software systems vary considerably from application to application. The architecture is the foundation of the system, and the choice and design of the system architecture is more important than the design of the functional structure of the system, the design of the database structure, and the writing of the program code. The following three types of system architecture are commonly used today.

The single-user architecture is the earliest version of a stand-alone management information system. Most of the current tools and software still follow this model. Each stand-alone system can only run on one computer and users cannot share data and work together directly.

C/S architecture, i.e., client and server architecture. C/s simulation can make use of the resource configuration of the client. The structure is shown in Figure 5.

The B/S architecture is a three-tier system based on the Internet. Under the B/S structure, the system is divided into three layers: the database service layer, the application service layer, and the user layer. The database management system is deployed on the database server to manage the data files. The system application is installed on the application server and the system program is run on the application layer, which generates the web interface for the user browser. The B/S architecture is currently the mainstream architecture for system development and is used by large enterprise groups and customers for decentralised applications.

Combining the many advantages of B/S structure design and the practical needs of this study, the design system of the teaching evaluation system adopts the B/S model. Figure 6 shows the schematic diagram of the B/S model structure.

The user representation layer is the interface that the user sees. It runs on the client computer and distributes

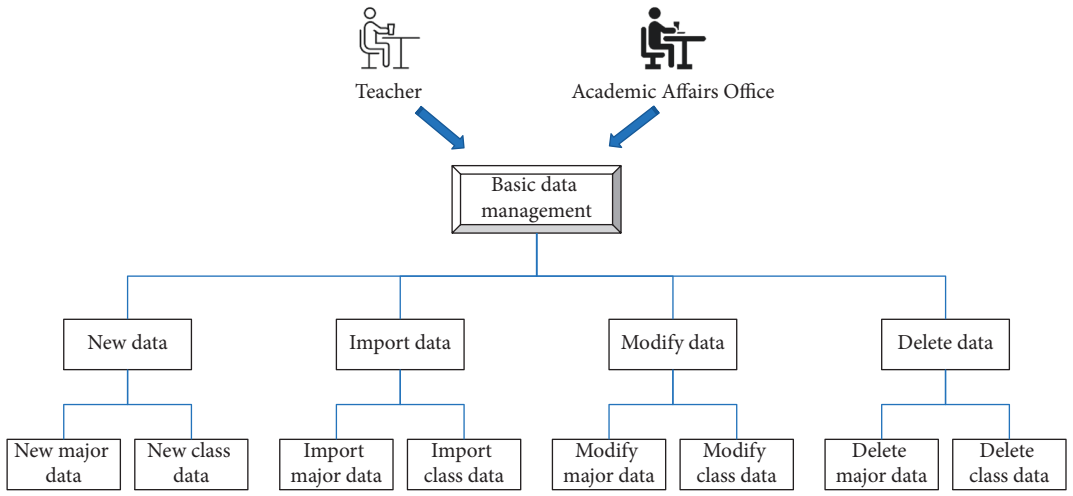

Figure 3: Basic data management use case diagram.

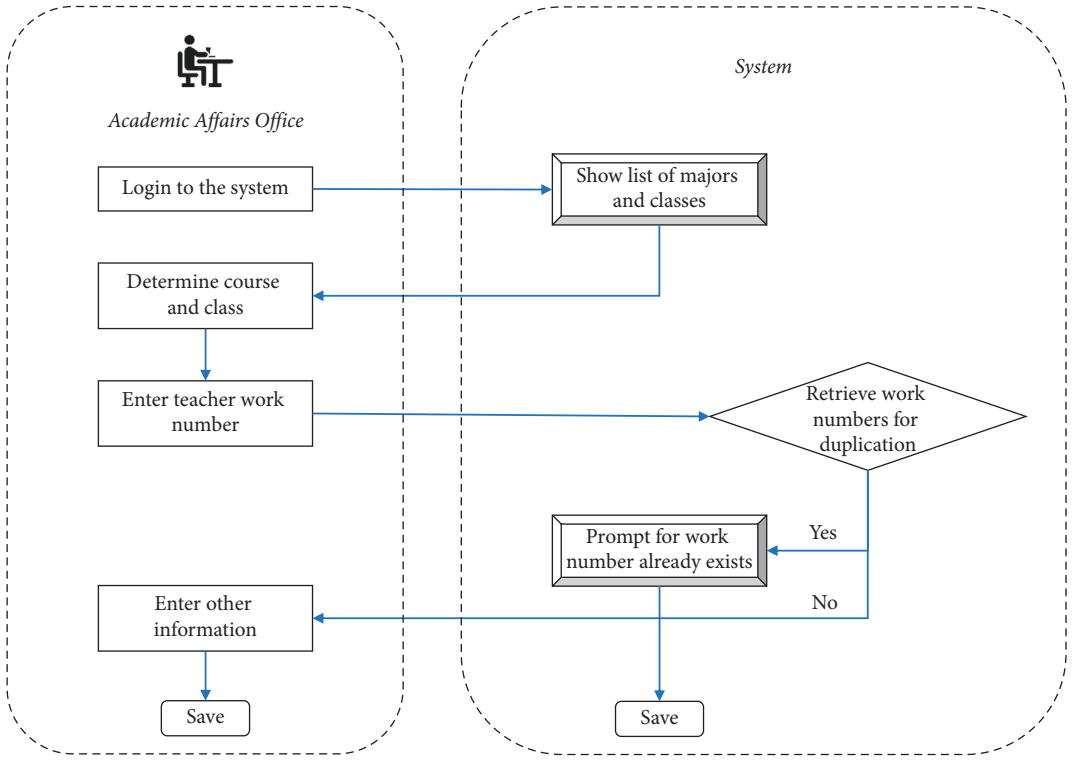

Figure 4: Teacher information addition activity diagram.

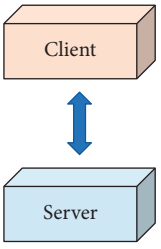

Figure 5: Structure of C/S architecture.

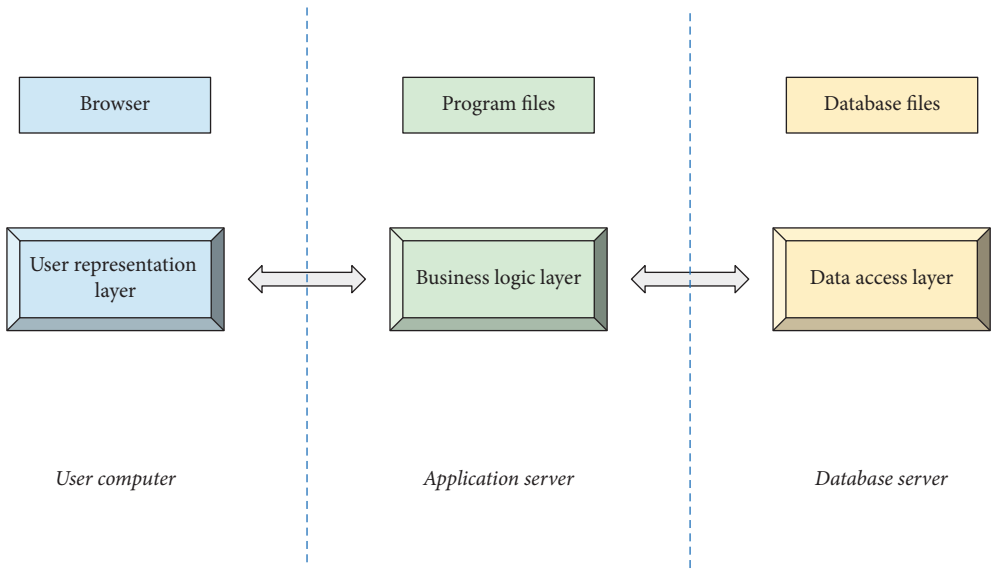

Figure 6: Schematic diagram of the B/S model structure.

information through a browser. The user can manipulate the business menus, send business requests to the server, and display the results returned by the server. The user representation layer does not perform any actual data processing but only transmits the user's instructions to the business logic layer.

The business logic layer receives processing instructions from the representation layer and mobilizes the program files to complete the business processing. At the same time, it generates data processing requests to the data access layer and generates a user interface with the data returned from the database, which is fed back to the user's computer browser.

The database management system and database files are deployed on the database server. The data access layer responds to data processing requests from the program files, writes, reads, and deletes data to the database and feeds the data processing results to the business logic layer.

4. Conclusion

The teaching evaluation system based on interval intuition fuzzy theory was developed mainly to meet the task of teaching evaluation in universities. The system can serve the teaching quality of the university in a fair and objective way. At the same time, the system can exchange data well with other management systems of the school such as the financial system to meet the practical daily needs of the school. The teaching evaluation system focuses on the problem of the large amount of data and the difficulty of statistical analysis, which is traditionally difficult to deal with in school teaching quality evaluation. The system also enables data sharing with other systems and solves the long-standing problem of low evaluation efficiency in schools. The paper proposes a four-layer structure based on the presentation layer, presentation control layer, business logic layer, and data layer. The detailed design of modules such as basic data management, evaluation scheme management, online marking and evaluation, teaching supervision data management, and evaluation process is completed through class diagrams and sequence diagrams, and the database design is completed through the database conceptual model and physical model. However, this study does not cover user security audit content, and this part of the work will be carried out in the next step to enhance the security audit design of user login logs.

Data Availability

The labeled data set used to support the findings of this study is available from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

Acknowledgments

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