International Journal of Science and Engineering Applications
Volume 15-Issue 09, 53 – 57, 2026, ISSN:- 2319 - 7560
DOI: 10.7753/IJSEA1509.1008

Intelligent Evaluation and Teaching Improvement Strategies for College Classroom Teaching Quality Based on Multi-source Data Fusion

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Abstract: There are several drawbacks in the assessment of classroom teaching quality in universities, such as limited data sources, long evaluation cycles, and insufficient diagnostic depth, which make it difficult to provide effective support for teaching improvement decisions. This paper proposes a quality education intelligent evaluation architecture based on multi-source data fusion. Through the complete process of data collection - intelligent analysis - closed-loop improvement, the intelligent evaluation of teaching quality is completed. Through research, it was found that the traditional evaluation method is to rely solely on subjective scores at the end of the semester, lacking objective evidence during the teaching process. By leveraging multi-source data fusion, various types of information such as behavior logs, video semantics, academic performance, and supervision evaluations can be collected, thereby achieving precise description of teaching quality and dynamic detection. Therefore, this paper presents a closed-loop mechanism of "evaluation - intervention - improvement", and explores the guarantee means for teaching improvement from the three levels of system, technology, and culture, hoping to provide some references for the digital transformation of the university's teaching quality improvement system.

Key words: Multi-source data fusion, Teaching quality evaluation, Intelligent evaluation, Teaching improvement, Data-driven

I. Introduction

The assessment of classroom teaching quality [1]-[7] is a core part of university teaching operations, directly related to the direction of teaching improvement and the effectiveness of resource allocation. However, the current teaching evaluations in most universities still mainly rely on the assessment of students' grades at the end of the semester and supervisory classroom observations. This evaluation method overly depends on subjective judgment, and the results are seriously delayed compared to the teaching implementation process, failing to truly achieve the effect of "evaluation promoting improvement". With the widespread application of smart classrooms, online teaching platforms, and educational administration systems, a large amount of data generated during classroom teaching can be collected. Various behavioral data such as classroom recordings, students' facial expressions, communication frequency, and homework completion routes all contain relevant information about teaching quality. How to effectively integrate these scattered data and create a scientific, objective, and real-time quality assessment system has become a key issue in the digitalization process of higher education.

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II. Limitations of Traditional Classroom Teaching Quality Assessment

2.1 Single Data and Evaluation Bias

The current student evaluation system adopted by universities is actually a post-event subjective evaluation. Research has shown that students' scores are influenced by various factors such as the difficulty of the course, the teacher's friendliness, and the leniency of the grading. There are also situations where the pass rate is high but the degree of differentiation is low. When Xi'an Jiaotong University conducted statistics on the traditional evaluation method, it was found that in the traditional evaluation method, the pass rate was 97%, which did not conform to the normal distribution law. Among the teachers ranked last, 16.67% raised objections. Such "all are good, everyone is happy" evaluation results cannot truly and objectively reflect the teaching level and cannot effectively promote teachers' reflection.

2.2 Lack of Process and Delayed Feedback

The traditional assessment focuses on "results" and neglects "process". It adopts a method of scoring only at the end of the course, without collecting dynamic information such as the interaction between teachers and students, the participation status of students, and their cognitive conditions during the classroom learning process. The evaluation results are only informed to the teachers at the end of the course, and by then, the teaching activities cannot be adjusted immediately. Some scholars have pointed out that the "emphasizing results and neglecting process" evaluation method leaves the quality assurance work in a "based on experience and intuition" loose state for most of the time.

2.3 Shallow Diagnosis and Ineffective Improvement

Although evaluation results are provided, the content of the feedback is only general statements such as "serious teaching attitude" and "thorough content", without structuringly diagnosing specific teaching problems. Teachers cannot use such evaluations to identify the problems in their teaching and the areas that need improvement. As some scholars have said, most evaluation results are used for grade assessment rather than for teachers' teaching improvement, with low utilization rate, so the evaluation effect is poor.

III. Construction of an Intelligent Evaluation Framework Based on Multi-source Data Fusion

3.1 Data Collection Layer: Integration of Multimodal Teaching Data

The foundation of intelligent evaluation lies in breaking down data barriers and establishing a data collection network covering the entire teaching cycle. The multi-source data should include the following aspects:

Firstly, behavioral data. The number of class attendance, the frequency of interaction with teachers and classmates, the duration of online learning, the time of submitting homework, and other platform log data can reflect the basic participation of students. After completing the renovation of the smart classroom at Henan University of Technology, they carried out the basic collection task of classroom behavior videos in 349 classrooms, recording the teaching and learning behaviors of 1,636 teachers and 31,992 students.

Secondly, semantic and emotional data. By using speech recognition, natural language processing, etc., to analyze classroom dialogues, find types of questions and discussions, depth of understanding, and other data, and observe students' facial expressions, the number of times they look up, their concentration and other factors, thereby evaluating the quality of classroom engagement. Nanjing Audit University has constructed a four-dimensional intelligent identification model of "cognition - emotion - action - environment", with an accuracy rate of 92.3%.

Thirdly, academic achievement data. Gather all the learning achievement data at various time points such as in-class tests, homework scores, and stage assessments, and regard them as real evidence of teaching effectiveness.

3.2 Intelligent Diagnosis Layer: Integration of Algorithms and Evaluation Models

Data fusion requires the use of scientific multi-source data fusion algorithms and quality evaluation models for teaching. According to research by China University of Mining and Technology, for data with time series characteristics, video image data, and other numerical data, they are processed separately and integrated according to the requirements of the course syllabus, and finally obtain quantitative and qualitative evaluation results. The specific method is as follows:

Task: Without affecting facts, terms, and word count (±10%), rewrite the following Chinese paragraph to be more natural and reduce the presence of AI, making it less noticeable. Original paragraph: Standardized Processing of Multi-source Data*. Unify the data formats and interface standards between different systems to eliminate "information islands". North China University of Water Resources and Electric Power has achieved direct connection between the teaching management system data and the online teaching platform and smart classroom data by building a smart teaching integrated platform.

IV. How Data-Driven Evaluation Promotes Teaching Reform

4.1 From "Vague Experience" to "Precise Diagnosis" for Teaching Improvement

Traditional teaching improvement relied on teachers' own thinking or listening to colleagues' opinions, without objective basis. Data-driven evaluation can identify teaching difficulties accurately. Teachers can compare their teaching videos with those of excellent teachers and find out the areas where there is too little interaction or the rhythm is incorrect during their own classes. Teacher Cao Meng from the Electronic College of Xi'an Jiaotong University improved his teaching by watching his own videos and those of the same class teachers, adjusting the speed of his lectures in a targeted manner, and thus enhancing the teaching effect. "Evidence-Based" teaching improvement has transformed from "adjusting based on intuition" to "based on data".

4.2 Differentiated Teaching and Personalized Learning Support

Multiple-source data not only assess teachers but also depict students' learning profiles. By analyzing data on students' mastery of knowledge, cognitive load, and learning strategies, the system can recommend personalized learning resources for students and also help teachers implement differentiated teaching. "Zhijiedong" teaching evaluation intelligent agent achieves "one plan for each student", as demonstrated by the practice of Beijing University of Science and Technology. The experience of Henan University of Technology tells us that when the proportion of "learning difficulties students" in a class continues to rise, teachers can promptly adjust the lecture pace, add special exercises, and change from "one-size-fits-all" to "precise assistance".

4.3 Formation of the "Evaluation - Feedback - Improvement" Closed Loop

Data-driven evaluation is ultimately implemented through a regular improvement mechanism. Xi'an Jiaotong University has established a three-level supervision system of school - college - department, conducting on-site evaluations for classroom problems, implementing约谈warnings，conducting progressive training， and inviting experts for consultation， thus forming a "evaluation - guidance - feedback - improvement" cycle process. Beijing University of Science and Technology uses data to promote the "evaluation - feedback - improvement - construction" quality circulation link， and combines multiple sources of data to promote the dynamic changes of the professional structure and achieve precise allocation of resources.

V. Implementation Path and Guarantee Strategies

5.1 Institutional Guarantee: Data Standards and Evaluation Norms

To promote the multi-source data fusion assessment, the first priority is to formulate data management regulations, delineating the scope of data collection, storage, utilization, and privacy protection. Additionally, the achievements of teaching improvement based on data should be incorporated into the assessment and evaluation systems of departments and teachers, creating a system where rewards and punishments coexist. Moreover, efforts should be made to align the internal evaluation norms of the school with the technical capabilities norms of industry professionals, ensuring the scientificity of the evaluation from the very beginning.

5.2 Technological Guarantee: Platform Construction and Composite Team

The school should adopt the approach of "overall planning, gradual implementation", first establishing a data hub and a smart educational ecosystem. The technical means must be open, scalable, and secure. A group of talents who understand both educational rules and data analysis should be cultivated to avoid the embarrassing situation of having a well-built system but facing the problem of "having data but not knowing how to use it".

5.3 Cultural Guarantee: Cultivating Data-Driven Quality Culture

The implementation of technology requires culture as the background. The school should create an atmosphere throughout the campus where "data is used to speak, decisions are made based on data, and improvements are achieved through data". Regularly release data white papers on teaching quality, hold teaching reflection seminars based on data, select and commend some good data application cases, etc., making data a consensus among everyone.

VI. Conclusion

The intelligent assessment of teaching quality based on multi-source data fusion represents a comprehensive innovation to the traditional evaluation model of teaching assessment. It transforms teaching evaluation from subjective scoring at the end of the term to data collection throughout the entire cycle, from vague empirical judgment to precise diagnosis, and from simple accountability measures to a source of motivation for teaching progress. Universities should seize the excellent opportunity of educational digital transformation, based on their own circumstances, and work diligently to establish the "data collection - intelligent diagnosis - closed-loop improvement" system, so that data can truly contribute to the growth of teachers and students, and promote higher education to enter a new stage of high-quality development.

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