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Research on the Construction and Practice of an Evidence-Based Value-Added Evaluation System Based on Data-Driven

Lingduo Yang[1]*, Lili Xu[1], Yan Xu[1], Furong Peng[1], Shuai Zhang[2]

[1]Shandong Labor Vocational and Technical College, Jinan 250000, Shandong, China
[2]Jicheng Electronics Co., LTD., Jinan 250000, Shandong, China

Author to whom correspondence should be addressed.

Abstract: Based on the educational evaluation reform, this study explores the construction of an evidence-based value-added evaluation system based on data-driven, aiming to solve the limitations of traditional evaluation methods. The research adopts the method of combining theoretical analysis and practical application, and designs the evidence-based value-added evaluation framework, which includes the core elements of a multi-source heterogeneous data acquisition and processing system, a value-added evaluation agent based on a large model, and an evaluation implementation and application mechanism. Through empirical research verification, the evaluation system has remarkable effects in improving learning participation, promoting ability development, and supporting teaching decision-making, and provides a theoretical reference and practical path for educational evaluation reform in the new era. The research shows that the evidence-based value-added evaluation system based on data-driven can reflect students' actual progress more fairly and objectively by accurately measuring the difference in starting point and development range of students, and provide strong support for the realization of high-quality education development.

Keywords: Data-driven; Evidence-based evaluation; Value-added evaluation; Large model; Educational evaluation reform

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1. Introduction

1.1. Research background and significance

As the "baton" of the education system, educational evaluation plays an important guiding role in the reform and development of education [1]. With the deepening of the digital transformation of education, the traditional results-oriented and single-dimensional evaluation method has been unable to meet the needs of education development in the new era. In 2020, the *Overall Plan for Deepening the Reform of Education Evaluation in*

the New Era issued by the CPC Central Committee and The State Council clearly points out that it is necessary to "establish a scientific evaluation system oriented by developing quality education," which points out the direction for the reform of education evaluation [2]. In this context, an evidence-based value-added evaluation system based on data-driven came into being. The evaluation system reflects the "people-oriented" education concept by accurately measuring the starting point difference and development range of students, focusing on the progress and growth of each student, rather than simply comparing the final score. At the same time, emerging technologies such as big data and artificial intelligence provide technical support for accurate, scientific, and efficient educational evaluation, making all-round, multi-dimensional, and process-based evaluation possible [3].

1.2. Research objectives and core issues

This study aims to build a data-driven, evidence-based value-added evaluation system and verify its effectiveness through practical application. The specific research objectives include: designing a multi-source heterogeneous data acquisition and processing system, developing a value-added evaluation agent based on a large model, constructing a scientific and feasible evaluation implementation path, and forming an education evaluation reform plan that can be promoted. The research focuses on solving the following core problems: (1) How to build a multi-source heterogeneous data acquisition and processing system to achieve effective transformation from data to evidence? (2) How to build value-added evaluation agents based on large model technology to improve the accuracy and intelligence of evaluation? (3) How to design the implementation path of an evidence-based value-added evaluation system to ensure the effective application of evaluation results?

2. Literature review

2.1. Research progress of value-added evaluation theory

Value-added evaluation originated in the 1990s and was initially used to measure the contribution of teachers and schools to students' academic progress [4]. The Tennessee Value-added Evaluation System (TVAAS), developed by Sanders, is an early representative value-added evaluation model [5]. In recent years, the theory of value-added assessment has undergone a transformation from a single-subject knowledge measurement to a multidimensional ability assessment, from a simple linear regression model to a complex multi-level model, and from a focus on teacher performance to a focus on the overall development of students [6]. Evidence-based evaluation originates from the idea of evidence-based education and emphasizes that evaluation decisions should be based on scientific evidence. Slavin pointed out that evidence-based education requires the use of "the best available evidence" to guide educational practice [7]. The reliability and validity of data and the science of interpretation are central elements in evidence-based evaluation.

2.2. Research on data application in educational evaluation

With the advent of the era of big data, the field of educational evaluation has changed from "data scarcity" to "data enrichment." The learning analysis developed by Siemens and Baker provides a theoretical basis for the in-depth mining of educational data [8]. Educational big data analysis technology has experienced a development process from descriptive analysis, diagnostic analysis, to predictive analysis and normative analysis, providing a full chain support for evaluation from "what" to "why" to "what will be" and "what should be done" [9]. In recent years, large model technology has shown great potential in the field of educational evaluation. Wang *et al.* have shown that intelligent evaluation systems based on large models can more accurately capture

students' cognitive development trajectory and provide personalized feedback and suggestions [10]. At the same time, multi-modal data fusion technology makes it possible to deeply understand and analyze unstructured educational data (such as text, images, audio, etc.) [11].

3. Multi-source heterogeneous data acquisition and processing system

3.1. Data sources and categorization analysis

The basis of constructing an evidence-based value-added evaluation system is to establish a comprehensive teaching platform process data classification framework. In this study, learning data is divided into three categories: (1) learning behavior data, including resource access data (frequency, duration, time distribution), interactive behavior data (speech, question, answer, discussion participation), operation trajectory data (page switching, tool use, annotation behavior), and task completion data (job submission, task progress, cooperative contribution); (2) learning outcome data, including formative assessment data (chapter tests, practical tasks, project performance), summative assessment data (final exam, comprehensive assessment, work results), ability performance data (problem solving, innovative design, communication and collaboration), and development trajectory data (continuous assessment results, growth archives); (3) learning attitude data, including affective state data (learning engagement, expression of interest, mood swings), self-cognition data (learning strategy, self-reflection, goal setting), social data (willingness to cooperate, team role, peer interaction), and value orientation data (learning motivation, career interest, achievement orientation). Student behavior data has a unique value in value-added evaluation: revealing learning habits and styles, providing early warning of learning risks, and discovering hidden tracks of ability development.

3.2. Data standardization processing methods

In order to ensure the quality and availability of multi-source heterogeneous data, this study constructs a data quality assessment and control mechanism that includes six dimensions, including completeness, accuracy, consistency, timeliness, interpretability, and compliance. For the learning behavior data, a standardized model with three layers is designed: the basic layer (unified data format and structure), the semantic layer (unified behavior description and classification), and the application layer (unified analysis index and method).

3.3. Transformation path from data to evidence

The transformation from data to evidence is the core link of evidence-based evaluation. This study established the "data-information-evidence-decision-making" transformation link, and proposed a five-level evidence classification standard: (1) first-level evidence: stable results from randomized controlled experiments; (2) second-level evidence: consistent findings from quasi-experimental studies; (3) third-level evidence: results from cross-validation of multi-source data; (4) fourth-level evidence: regular findings from systematic observation; and (5) fifth-level evidence: conclusions from case studies and expert judgment. In order to ensure the reliability and validity of the evidence, the research adopts a verification mechanism combining triangulation, peer review, and external expert review.

4. Construction of a value-added evaluation agent based on a large model

4.1. Design of value-added index system

The multidimensional value-added index system is the core of evaluation. This research constructs a value-

added index system based on four dimensions: subject knowledge, core competence, learning quality, and comprehensive literacy. The starting point difference calculation model adopts the method of multiple regression and hierarchical analysis, considering the students' basic level, learning conditions, and individual characteristics, and builds an objective value-added benchmark line. The method of expert judgment, data-driven, and large model assistance is adopted to determine the weight of the index to ensure a scientific and reasonable weight distribution.

4.2. Large model-assisted evaluation mechanism

The application of a large model in educational evaluation is mainly reflected in three aspects: data analysis, multi-modal data fusion, and value-added prediction. Especially in the assessment of complex non-cognitive ability, a large model shows the advantages that traditional statistical methods do not have. The value-added prediction and real-time feedback algorithm developed in this study is based on the big model parameter θ, and integrates historical data (H), current state (C), and situational factors (E) to achieve an accurate prediction of students' value-added trend: $\Delta V = f(H, C, E, \theta)$. The prediction results form three types of key information: risk warning, value-added prediction, and intervention suggestions, and transform the technical analysis into concrete feedback that is easy to understand through the natural language generation ability of the large model [12].

4.3. Evaluation of agent architecture and implementation

The evaluation agent adopts a "four-layer architecture," including data layer, model layer, application layer, and interaction layer, and realizes the intelligent processing of the whole process from data collection to result presentation. The core functional modules include a data integration engine, a multidimensional modeling system, an analysis and prediction center, and a personalized feedback generator. All modules work together to form a closed-loop evaluation ecology. The interactive interface of the agent has designed differentiated interfaces for teachers, students, and administrators to meet the needs of different users, while focusing on the simplicity, intuitiveness, and operability of the user experience.

5. Implementation and application of the evidence-based value-added evaluation system

5.1. Operational mechanism of the evaluation system

The operation of the evidence-based value-added evaluation system relies on the "four-in-one" evaluation integration model, which takes teachers, students, system, and managers as the core elements, and forms an organically integrated evaluation ecology by clarifying the responsibilities of all parties and establishing close connections [13]. The data-driven evaluation implementation process includes evaluation planning and goal setting, learning starting point data collection, process data continuous collection, agent data analysis and prediction, feedback and intervention, etc., forming a closed-loop optimization path. The application path of evaluation results covers four dimensions, namely individual learning, teaching improvement, school management, and education policy, to ensure that evaluation results can serve different levels of educational decision-making and practice improvement.

5.2. Teaching practice application cases

In this study, the course Data Analysis and Application in colleges and universities is selected as a practical scenario to carry out a one-semester application of the evidence-based value-added evaluation system.

The practical results show that the evidence-based value-added evaluation system has significant effects on improving learning engagement (28.5%), promoting ability development (31.7%), and enhancing learning motivation (25.3%). Following the analysis of typical cases, it is found that there are three kinds of differentiation in ability development of different students: starting point differentiation, value-added differentiation, and development track differentiation. The multidimensional ability analysis of individual students shows that students have significant growth in different ability dimensions (knowledge mastery, problem analysis, tool application, innovative thinking, collaboration ability, and reflection ability), especially in tool application and reflection ability. These findings confirm the concept of personalized education and provide a scientific basis for targeted teaching. The evidence-based value-added evaluation system provides strong support for teachers' decision-making on teaching improvement, helps teachers accurately identify teaching problems, design differentiated teaching strategies, and optimize the allocation of teaching resources [14].

5.3. Verification of evaluation effect

The reliability of the evaluation results was tested by triangular verification method, and the results showed that: the internal consistency of the multidimensional value-added index system was high (± 0.83); it is correlated with the traditional evaluation but not completely coincident (r = 0.76); high predictive validity for subsequent performance (0.74); and good temporal stability. The acceptance survey of teachers and students of the evidence-based value-added evaluation system shows that the overall acceptance is high (4.21/5), especially in the aspects of fairness, personalization, and supporting learning improvement, which is significantly higher than the traditional evaluation [15]. At the same time, it is also found that three aspects of system usability, evaluation results interpretation support, and technical training need to be improved. Based on practice verification and feedback, the study adopted a step-by-step iterative optimization strategy to continuously improve the evaluation system in four aspects of ease of use improvement, explanatory enhancement, technology upgrading, and application expansion, and formed a mature education evaluation solution.

6. Research conclusion and prospects

6.1. Summary of main research results

This research has achieved a series of achievements in three aspects: theoretical framework innovation, technical method breakthrough, and practical application results. At the theoretical level, it constructs a theoretical framework integrating data-driven, evidence-based concepts, and value-added evaluation. At the technical level, the standardization model of learning behavior data, the calculation model of starting point difference, and the value-added prediction mechanism based on a large model are developed. At the practical level, a comprehensive application system covering student learning, teaching improvement, and management support has been formed.

6.2. Research limitations and future research directions

Research limitations are mainly reflected in three aspects: at the theoretical level, the applicability of the subject is limited, and the cross-cultural adaptability is insufficient; at the technical level, the comprehensiveness of data is still challenged, and the interpretability of large models is insufficient; at the application level, the sample representation is insufficient, and the promotion conditions are high. Future research can be further explored in four directions: theoretical expansion (interdisciplinary theory integration, evaluation ethics theory construction), technical deepening (multi-modal perception technology, causal inference model), application

expansion (basic education adaptation, vocational education application), and policy support (standard and norm research, evaluation policy innovation), so as to jointly build a more complete evidence-based value-added evaluation ecosystem. In short, the research on the evidence-based value-added evaluation system based on data-driven is a frontier field full of challenges and opportunities. Future research needs to pay more attention to the educational value and humanistic care of evaluation while promoting the progress of evaluation technology, so as to truly realize the reform goal of "people-oriented" education evaluation.

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Disclosure statement

The authors declare no conflict of interest.

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