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Constructing a Theoretical Framework and Evaluation Index System for Classroom Teaching Competence in Mathematics Teacher Candidates

Zhao Zixi
Changsha Normal University, Changsha,Hunan, China

Abstract: As teacher education reforms deepen and the professionalization requirements for mathematics teaching increase, constructing a scientific and systematic theoretical framework for evaluating the classroom teaching ability of mathematics teacher trainees has become a critical issue for optimizing the quality of teacher education. This paper, based on PCK theory, constructivist learning theory, and developmental evaluation theory, systematically analyzes the core components of the teaching ability of mathematics teacher trainees. It constructs a multi-dimensional evaluation framework that covers' teaching design—classroom

Keywords: Theoretical Framework and Evaluation Index System; Classroom Teaching Competence; Mathematics Teacher Candidates

1. Introduction

Implementation—subject literacy—evaluation reflection' from a theoretical perspective. By applying hierarchical design principles, it establishes a three-tier structure of goal layer, dimension layer, and indicator layer, detailing the evaluation indicators under each dimension and explaining their theoretical logic, thus forming an evaluation system that is systematic, adaptable, and developmental. The theoretical framework aims to provide a structured reference for the scientific assessment of the teaching ability of mathematics teacher trainees and to lay a theoretical foundation for the reform of teacher education courses and the design of ability cultivation paths. Future research will dynamically optimize the content of the framework in line with the evolution of educational concepts, promoting the theoretical depth and practical transformation of the evaluation system. Keywords: mathematics teacher trainees; classroom teaching ability; evaluation system Introduction This study focuses on theoretical construction, integrating the characteristics of pedagogy and mathematics with evaluation theory to design a clear and logically rigorous evaluation index system. The aim is to provide a theoretical basis for the scientific assessment and professional development of the teaching ability of mathematics teacher trainees, thereby contributing to the structural optimization of teacher education reform. As educational reforms deepen, cultivating mathematics teacher candidates with comprehensive qualities and innovative capabilities has become a key objective of higher education [1]. Classroom teaching skills are a core component of the professional development of mathematics teacher candidates, directly impacting the quality and effectiveness of future teaching. Establishing a scientific and systematic evaluation system for classroom teaching skills among mathematics teacher candidates is crucial for enhancing their teaching standards and the overall quality of teacher education. However, the current evaluation of classroom teaching skills in mathematics teacher candidates lacks a robust theoretical framework and practical guidance, necessitating the development of a scientific evaluation system through the refinement of this framework [2]. This study aims to develop a theoretical framework for evaluating classroom teaching skills, promoting the scientific assessment of these skills among mathematics teacher candidates, and providing a reference for the reform and development of teacher education.

2. Research Status

Theoretical Support for Evaluating Classroom Teaching Competence Classroom teaching competence is a critical factor influencing the

quality of education, and existing research has generally focused on its core components.

Shulman (1987) introduced the concept of 'pedagogical content knowledge' (PCK), which emphasizes the integration of subject content knowledge, teaching methods, and educational psychology. This concept has become a key reference framework for evaluating teachers 'teaching abilities [3]. It provides a core dimension for assessing the teaching abilities of mathematics teacher candidates. Building on this, constructivist learning theory further suggests that teachers should promote students' deep understanding and transfer skills through knowledge construction activities, which requires the evaluation system to focus on the logical teaching design and interactive guidance abilities of teacher candidates. Furthermore, developmental evaluation theory highlights the dynamic and diagnostic aspects of evaluation, advocating for the use of multi-dimensional and process-oriented indicators to reflect the progressive characteristics of teachers 'abilities, providing methodological guidance for the hierarchical design of this research framework. The theory of teacher professional development emphasizes that teacher growth is a continuous process, and the evaluation of teaching ability should reflect stage-specific features, with a focus on teachers' practical reflection and improvement skills. Additionally, developmental evaluation theory stresses the diagnostic and improvement functions of evaluation, advocating for the use of multi-dimensional and process-oriented evaluations to enhance teachers' abilities, providing methodological support for the construction of the classroom teaching ability evaluation system for mathematics teacher candidates. The theoretical essence of the classroom teaching ability of mathematics teacher candidates can be defined as: a comprehensive capability that promotes students 'knowledge construction and core competencies through systematic teaching design, classroom implementation, and reflective improvement, grounded in mathematical professional knowledge and educational theory. This capability comprises four core components: knowledge elements (mathematical subject knowledge and educational theory), skill elements (teaching design and classroom management), educational elements (the integration of mathematical culture and value guidance), and development elements (critical reflection and innovation). These four components form the foundational logic of the theoretical framework[1].2. Theoretical Analysis and Hierarchical Design of Evaluation Dimensions

The evaluation of the classroom teaching ability of mathematics teacher candidates requires the establishment of a scientific and comprehensive evaluation dimension to ensure a systematic and objective assessment of their teaching abilities. When constructing the evaluation framework, it is essential to integrate theories of mathematics pedagogy, educational evaluation, and relevant research findings, considering the core competency requirements of mathematics teacher candidates in practical teaching. The determination of evaluation dimensions should be based on the Ministry of Education's standards for teacher candidate training, while also drawing on the research outcomes of domestic and international mathematics teacher evaluation systems. The unique nature of mathematics teaching means that the teaching ability of mathematics teacher candidates encompasses not only general teacher competencies but also aspects such as subject teaching design, mathematical thinking cultivation, and information technology teaching capabilities. Therefore, the evaluation dimensions should cover core elements such as teaching design, classroom implementation, mathematical subject literacy, teaching evaluation and reflection, information technology teaching, and practical innovation and development. Based on the PCK theory and developmental evaluation theory, this study constructs an evaluation framework from four dimensions: Teaching Design Ability: This includes the alignment of teaching objectives with curriculum standards, the logical organization of teaching content, and the appropriate design of teaching methods; Classroom Implementation Ability: This covers the clarity of teaching language, the effectiveness of classroom interaction, and the diversity of teaching strategies; Mathematical Literacy: This focuses on the depth of mathematical knowledge, the ability to integrate mathematical ideas and methods, and the awareness of spreading mathematical culture; Evaluation Reflection Ability: This

involves the scientific nature of teaching feedback, the ability to analyze student learning outcomes, and the practical transformation of teaching improvements. These dimensions follow a logical chain of 'goal-process-result,' forming a three-tier theoretical framework: 'Goal Layer (Ability Development) → Dimension Layer (Core Ability) → Indicator Layer (Specific Elements).' This design not only highlights the unique aspects of mathematics teaching, such as the cultivation of abstract thinking, but also takes into account the dynamic characteristics of teacher professional development, such as the advancement of innovative abilities.

3. Establishment of Evaluation Index System

Theoretical Adaptation and Hierarchical Design of Evaluation Indicators In the process of constructing an evaluation framework for the classroom teaching abilities of mathematics teacher candidates, the design of evaluation indicators is crucial.

A scientific and reasonable evaluation indicator system not only helps to comprehensively assess the teaching abilities of mathematics teacher candidates but also provides a solid foundation for the reform of teacher education and talent development. This study, based on a clear understanding of the evaluation dimensions, constructs an indicator system that encompasses core teaching skills through systematic analysis. The setting of evaluation indicators should adhere to the principles of scientificity, systematicness, operability, and developmental nature. Scientificity requires that the evaluation indicators be grounded in mathematics education theory and the framework of teacher professional development, ensuring their theoretical support and effectiveness. Systematicness emphasizes the logical connections between indicators, ensuring that the evaluation system comprehensively covers all aspects of the teaching abilities of mathematics teacher candidates. Operability means that the indicators must have clear assessment standards and can be evaluated through quantitative or qualitative analysis. Developmental nature emphasizes that the indicator system should accommodate the dynamic nature of teacher growth, adapting to future educational reforms and changes in mathematics teaching methods. In the specific design process, evaluation indicators are detailed according to different ability dimensions, with several specific indicators under each dimension, forming a clear and well-structured evaluation system. Under the teaching design ability dimension, indicators such as "reasonableness of teaching goal setting," "logic of teaching content organization," and "effectiveness of teaching method selection" can be established. Under the classroom implementation ability dimension, indicators such as "clarity of teaching language expression," "classroom interaction and guidance ability," and "diversity of teaching strategies" can be included. Regarding the mathematical literacy of teacher candidates, the evaluation can assess their depth of mathematical knowledge, their ability to integrate mathematical thinking and methods, and their understanding and dissemination of mathematical culture. Additionally, the teaching evaluation and reflection skills should cover aspects such as the scientific nature of teaching evaluation methods, the ability to analyze feedback on student learning outcomes, and the depth of teaching reflection and improvement measures, ensuring that teacher candidates have the capability to continuously optimize their teaching. In terms of quantifying evaluation indicators, methods like the Likert scale can be used to set clear scoring criteria for each indicator[3]. For instance, the reasonableness of setting teaching objectives can be assessed from 'fully in line with curriculum standards' to 'clearly deviating from teaching requirements,' setting multiple levels to ensure the objectivity and comparability of the evaluation results. At the same time, a diversified evaluation approach, including expert ratings, peer reviews, student feedback, and self-assessment, can enhance the comprehensiveness and fairness of the evaluation[4]. To ensure the applicability and effectiveness of the evaluation indicators, the indicator system should be adjusted and optimized through methods such as expert consultations, empirical analysis, and data validation. The Delphi method can be used to gather opinions from educational experts and front-line mathematics teachers, combined with actual classroom teaching cases for verification, and statistical analysis of the indicators'

discriminative power, reliability, and validity. Through dynamic adjustments and optimizations, an evaluation indicator system that meets the development needs of teaching abilities of mathematics teacher candidates and adapts to educational practices can be formed, providing scientific support for subsequent teaching ability evaluations and improvements. The construction logic and optimization path of the theoretical framework. The evaluation framework should adhere to the principles of comprehensiveness, hierarchy, operability, and dynamic development. Comprehensiveness ensures that the framework covers multiple core dimensions of mathematics teacher education students 'classroom teaching abilities, ensuring the completeness of the evaluation content. Hierarchy emphasizes a clear structure and well-organized indicator system, enabling precise assessment of various abilities. Operability requires that the evaluation indicators have clear standards and can be effectively assessed through quantitative or qualitative methods[5]. Dynamic development emphasizes that the evaluation framework should continuously optimize to adapt to the evolving educational philosophies and teaching methods, meeting the demands of mathematics education reform. In terms of specific design, the evaluation framework constructed in this study adopts a three-tier structure of' goals—dimensions—indicators 'to ensure the systematicness and logic of the evaluation. The first tier is the evaluation goal, which measures the development level of mathematics teacher education students' classroom teaching abilities, reflecting the ultimate value of teacher education. The second tier is the core evaluation dimensions, covering key aspects such as teaching design ability, classroom implementation ability, mathematical subject literacy, and teaching evaluation and reflection ability. The third tier consists of specific evaluation indicators, achieving operational analysis of ability elements through detailed observation points (such as 'the ability to integrate mathematical thinking methods'). To ensure the applicability and scientific nature of the evaluation framework, a dynamic optimization mechanism should be established to provide regular feedback and adjustments on the evaluation results. Statistical analysis of evaluation data is used to assess the reliability and validity of each indicator, optimizing the evaluation standards and assessment tools. Extensively gather opinions from mathematics education experts and frontline teachers, and continuously refine the evaluation system to meet new demands in educational practice. Additionally, leverage information technology tools such as intelligent teaching evaluation systems and big data analysis to enhance the accuracy and efficiency of evaluations, providing long-term support for the development of classroom teaching skills among mathematics teacher candidates. The optimization process includes: theoretical iteration, integrating emerging educational theories (such as generative AI in teaching) to update the connotations of evaluation indicators; dynamic adaptation, adjusting the weight of dimensions based on mathematics curriculum reforms (such as the implementation of new curriculum standards); interdisciplinary integration, incorporating interdisciplinary perspectives (such as brain science and cognitive psychology) to refine the evaluation logic. Conclusion: This paper constructs a theoretical framework for evaluating the classroom teaching abilities of mathematics teacher candidates through theoretical integration and logical deduction. Its core value lies in providing a structured and subject-specific theoretical reference for the assessment of teacher candidates 'abilities. Future research should further deepen the connection between the framework and educational practice, explore feasible pathways for transforming theoretical models into training courses and evaluation tools, and promote the transition of teacher education from' experience-driven 'to' theory-guided.'

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