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RESEARCH ARTICLE

Theoretical and Methodological Foundations of Assessing Prospective Biology Teachers' Quasi-Professional Activities

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Abstract

The assessment of prospective biology teachers' quasi-professional activities represents an important component of improving professional teacher preparation in higher education. Contemporary science education requires future teachers to demonstrate not only biological knowledge but also pedagogical reasoning, scientific inquiry skills, instructional planning abilities, and competence in evaluating students' learning outcomes. This study examines the theoretical and methodological foundations of assessing quasi-professional activities and explores the possibilities of adapting international educational frameworks to the professional preparation of biology teachers. The research employs qualitative content analysis of scientific publications, assessment theories, and internationally recognized educational frameworks, including the OECD PISA 2025 Science Framework and the UNESCO ICT Competency Framework for Teachers. The findings identify the principal components of quasi-professional performance and substantiate a competency-oriented assessment approach incorporating biological content knowledge, methodological decision-making, scientific inquiry, instructional communication, and reflective evaluation. Particular attention is given to performance-based assessment, analytical rubrics, authentic pedagogical situations, and the validity of assessment procedures. An integrated conceptual assessment framework is proposed to support the systematic evaluation of prospective biology teachers' professional readiness. The study concludes that internationally informed assessment practices should be adapted to the requirements of teacher education and verified through empirical investigation before their broader implementation.

KEYWORDS

Prospective biology teachers, quasi-professional activities, professional competence, assessment methodology, international educational frameworks, performance-based assessment, scientific inquiry, pedagogical simulation, assessment criteria.

INTRODUCTION

The modernization of higher pedagogical education requires reconsideration of traditional approaches to evaluating prospective teachers' professional preparation. Contemporary educational institutions increasingly emphasize practical competence, scientific reasoning, pedagogical flexibility, and the ability to organize learning activities in accordance with students' individual needs. These requirements are particularly significant in biology education, where teachers must integrate scientific knowledge, experimental procedures, environmental understanding, and effective instructional methods.

Professional preparation cannot be adequately evaluated

through theoretical examinations alone. Although written tests provide information about students' subject knowledge, they may not fully demonstrate their ability to organize biological experiments, explain scientific phenomena, manage classroom interactions, or make pedagogically justified decisions. Consequently, assessment procedures should include activities that approximate the authentic conditions of professional teaching.

Quasi-professional activity can be understood as educationally organized performance that reproduces essential characteristics of professional situations without requiring full responsibility for an actual classroom. Within biology teacher education, such activities may involve simulated lessons, instructional case analysis, laboratory demonstrations, educational problem-solving, and the development of assessment materials.

The theoretical significance of this approach is associated with the relationship between professional knowledge and its practical application. Shulman [1] emphasizes that effective teaching involves comprehension, pedagogical reasoning, transformation of subject knowledge, and reflective evaluation. This perspective suggests that prospective teachers should be assessed according to their ability to transform biological concepts into scientifically accurate and pedagogically accessible learning experiences.

Grossman, Hammerness, and McDonald [2] argue that teacher education should provide opportunities to develop professional practices through activities connecting theoretical preparation with instructional performance. Their interpretation of practice-oriented teacher education supports the use of simulated professional situations as meaningful components of teacher preparation.

International educational frameworks provide additional methodological perspectives. The OECD PISA 2025 Science Framework identifies scientific explanation, the evaluation of scientific investigations, critical interpretation of evidence, and informed decision-making as important science competencies [3]. Although this framework primarily concerns students' scientific competencies rather than teacher certification, its conceptual structure can inform the development of biology-specific assessment tasks.

The UNESCO ICT Competency Framework for Teachers emphasizes the relationship between digital technologies, pedagogical practices, curriculum organization, assessment, and professional learning [4]. Its principles can contribute to evaluating prospective teachers' readiness to integrate digital resources into biology instruction.

Nevertheless, international frameworks should not be transferred mechanically into teacher assessment systems. Their original purposes, target populations, and competency definitions must be considered when adapting them to quasi-professional activities.

The purpose of this study is to examine the theoretical foundations of assessing prospective biology teachers' quasi-professional activities and substantiate a conceptual methodology for evaluating professional competence through internationally informed performance-based assessment.

The study employed qualitative content analysis of scientific literature, theoretical models of professional teacher preparation, and internationally recognized educational assessment frameworks. This methodological approach was selected to identify relevant assessment principles and develop a coherent conceptual structure without presenting unverified experimental outcomes.

The documentary materials included research addressing pedagogical content knowledge, practice-oriented teacher education, educational measurement, formative assessment, scientific competencies, and digital pedagogical competence.

Shulman's conception of pedagogical reasoning [1] and the practice-oriented approach developed by Grossman and colleagues [2] were used to explain the professional characteristics of quasi-professional activities.

The OECD PISA 2025 Science Framework [3] and UNESCO ICT Competency Framework for Teachers [4] were examined to identify science-related and digital pedagogical competencies that could be adapted for the professional assessment of prospective biology teachers.

The methodological analysis additionally considered the Standards for Educational and Psychological Testing [5], Messick's validity framework [6], and Brookhart's principles of analytical rubric development [7].

The analytical procedure involved interpreting the selected sources, identifying common theoretical characteristics, and comparing their implications for the assessment of professional teaching performance.

Particular attention was given to the relationship between assessment objectives, observable professional behaviors,

evaluation criteria, and evidence supporting the interpretation of assessment results.

The analysis distinguished science competencies demonstrated by school students from professional competencies expected of prospective teachers. This distinction was necessary to avoid directly applying student assessment frameworks to a different educational population.

The synthesized findings were used to formulate a conceptual assessment approach integrating authentic professional tasks, criterion-referenced evaluation, feedback, and reflective analysis.

The study did not involve experimental groups, interviews, questionnaire surveys, or statistical processing of student performance. Therefore, the findings represent theoretical and methodological results derived from documentary analysis rather than experimentally established effectiveness.

The theoretical analysis established that assessing prospective biology teachers' quasi-professional activities requires a multidimensional understanding of professional competence. The assessment process should consider not only the accuracy of biological knowledge but also the ability to apply this knowledge in instructional situations requiring methodological reasoning and pedagogical judgment.

The first significant finding concerns the relationship between subject knowledge and pedagogical transformation. Biological competence becomes professionally meaningful when prospective teachers can explain concepts according to learners' cognitive characteristics, select appropriate representations, and anticipate possible misconceptions.

For example, a prospective teacher preparing a lesson on photosynthesis must demonstrate scientific understanding of the process while selecting instructional explanations, visual representations, and experimental activities suitable for a particular group of learners.

Evaluation in this context should consider scientific accuracy, clarity of explanation, instructional relevance, and the correspondence between learning objectives and selected methods. These criteria reflect the relationship between disciplinary knowledge and pedagogical content knowledge emphasized by Shulman [1].

The second finding identifies scientific inquiry as an essential component of biology teachers' quasi-professional performance. The PISA 2025 Science Framework emphasizes the ability to explain phenomena scientifically, evaluate investigations, interpret evidence critically, and use scientific information for informed decision-making [3].

For prospective biology teachers, these competencies require pedagogical adaptation. Assessment should determine whether the future teacher can formulate meaningful inquiry questions, select appropriate experimental procedures, explain variables, identify limitations of evidence, and guide learners toward scientifically justified conclusions.

A simulated lesson concerning the influence of environmental conditions on seed germination illustrates this relationship. The prospective teacher may be required to formulate a research question, identify independent and dependent variables, determine controlled conditions, and explain how experimental observations should be interpreted.

Such activities provide opportunities to evaluate both scientific reasoning and the instructional organization of inquiry-based learning.

A third finding concerns the methodological importance of simulated pedagogical situations. Quasi-professional assessment should reproduce essential characteristics of teaching while maintaining conditions suitable for observation, feedback, and improvement.

Microteaching, instructional simulations, and pedagogical case analysis allow prospective teachers to demonstrate professional decisions in situations that approximate classroom practice.

For example, an assessment scenario may present a classroom situation in which students incorrectly assume that all microorganisms are harmful. The prospective teacher must identify the misconception, formulate an appropriate explanation, and select an instructional strategy that supports conceptual understanding.

The educational value of this task lies in evaluating the connection between biological content knowledge, pedagogical diagnosis, and methodological decision-making.

The fourth finding relates to the importance of transparent and criterion-based evaluation. Analytical rubrics provide an appropriate methodological instrument because they describe observable characteristics of performance and distinguish different levels of achievement.

Brookhart [7] explains that effective rubrics connect evaluation criteria with learning objectives and provide

meaningful descriptions of performance quality.

In quasi-professional biology teacher assessment, criteria may reflect the scientific validity of instructional content, coherence of lesson organization, appropriateness of teaching methods, quality of inquiry-based activities, communication effectiveness, and reflective evaluation.

The assessment process becomes more informative when each criterion is accompanied by clearly differentiated performance descriptors. Such descriptors enable evaluators to distinguish between the basic reproduction of teaching procedures and the independent, contextually justified application of professional knowledge.

Another finding concerns the integration of digital pedagogical competence. Contemporary biology instruction increasingly involves digital simulations, electronic laboratory materials, visual representations, and online scientific resources.

The UNESCO ICT Competency Framework for Teachers [4] provides a relevant theoretical basis for examining how digital resources can support instructional planning and professional teaching practices.

However, digital competence should not be evaluated solely through the ability to operate technological tools. Assessment should consider whether prospective teachers select technologies according to educational objectives, scientific content, student accessibility, and the requirements of instructional activities.

The synthesis also demonstrates the importance of reflective competence. Effective professional preparation requires prospective teachers to analyze their instructional decisions, recognize methodological limitations, and identify possibilities for improvement.

Reflective evaluation may be organized through structured self-assessment, feedback analysis, or the revision of previously developed lesson plans. These activities provide evidence of students' capacity for professional learning.

On the basis of these findings, a conceptual assessment framework is proposed that connects biological knowledge, inquiry-based instruction, pedagogical decision-making, digital methodological competence, and reflective evaluation.

The framework assumes that professional readiness should be evaluated through multiple sources of evidence rather than a single performance task.

Its implementation would require clearly defined competency indicators, standardized assessment instructions, analytical performance descriptors, and procedures for reviewing the consistency of evaluator judgments.

This proposed framework constitutes the main methodological result of the present theoretical investigation. Its diagnostic reliability and practical effectiveness remain subjects for future empirical examination.

The findings indicate that the assessment of prospective biology teachers' quasi-professional activities should be based on the relationship between authentic pedagogical performance and scientifically justified evaluation procedures.

The principal advantage of quasi-professional assessment lies in its capacity to reveal how prospective teachers apply theoretical knowledge when responding to instructional challenges. However, the authenticity of professional simulations does not automatically guarantee the validity of assessment results.

Messick [6] argues that assessment validity concerns the interpretation and use of scores rather than the assessment instrument considered in isolation. This position is especially important when evaluation outcomes are used to determine professional readiness.

A prospective teacher may demonstrate strong performance in a carefully prepared microteaching session while experiencing difficulties in spontaneous classroom situations. Consequently, assessment conclusions must reflect the conditions under which evidence was collected.

The Standards for Educational and Psychological Testing [5] provide an important methodological foundation for addressing these concerns. Evidence supporting score interpretation, reliability, fairness, and appropriate assessment use should be considered when developing professional evaluation procedures.

For quasi-professional assessment, this implies the need to establish a clear relationship between the intended competency, the professional task, the observed behavior, and the resulting evaluation.

Assessment quality may be weakened when indicators are excessively general. For example, describing performance as demonstrating good teaching ability does not explain which observable professional behaviors support the conclusion.

More informative criteria distinguish the accuracy of scientific

explanations, the appropriateness of learning activities, the justification of methodological choices, and the quality of interaction with learners.

The application of internationally recognized frameworks requires particular methodological caution. PISA 2025 provides a science competency framework intended for assessing student performance, whereas the UNESCO framework addresses teachers' digital professional competence.

These frameworks differ in objectives and assessment contexts. Therefore, their integration into a quasi-professional assessment methodology requires conceptual adaptation rather than direct reproduction of existing indicators.

Scientific inquiry competencies may inform the development of biology teaching simulations, while digital competence indicators can contribute to evaluating the purposeful selection of educational technologies.

Nevertheless, the professional competence of a biology teacher extends beyond these dimensions. Classroom communication, ethical responsibility, educational differentiation, assessment literacy, and reflective decision-making must also be considered.

The study consequently supports an integrated assessment model in which international science education frameworks are interpreted alongside established theories of teacher preparation.

An additional issue concerns the relationship between formative and summative evaluation. Summative assessment provides information about demonstrated achievement at a particular stage, whereas formative assessment supports professional improvement through feedback and reflection.

In quasi-professional activities, these purposes should complement one another. The assessment process can identify current levels of competence while simultaneously providing prospective teachers with specific information about the quality of their instructional decisions.

This relationship is particularly relevant to laboratory-based biology education, where teaching performance depends on scientific reasoning, organizational accuracy, and the safe management of practical activities.

For example, evaluating a simulated laboratory lesson requires consideration of experimental design, safety precautions, instructional instructions, student participation, and interpretation of observations. Focusing exclusively on the scientific correctness of the experiment would provide an incomplete representation of professional competence.

The methodological implications extend to pedagogical higher education institutions in Uzbekistan, where improving the relationship between theoretical instruction and practical teacher preparation remains an important educational objective.

An assessment system incorporating simulated teaching, biological inquiry tasks, methodological cases, and reflective analysis could provide a more comprehensive representation of prospective teachers' professional readiness.

However, the proposed framework should be tested before institutional implementation. Empirical validation would require evaluating the relevance of its criteria, the consistency of assessor judgments, and the relationship between simulation performance and subsequent teaching practice.

Such investigation would also help establish whether the assessment approach functions consistently across different biology topics, student proficiency levels, and educational settings. The present study therefore offers a methodological foundation for further research rather than evidence of an already validated assessment system.

The theoretical analysis demonstrates that assessing prospective biology teachers' quasi-professional activities requires a competency-oriented methodology integrating biological knowledge, scientific inquiry, pedagogical reasoning, instructional decision-making, and reflective evaluation.

Quasi-professional assessment provides a conceptual means of examining how prospective teachers apply theoretical knowledge in simulated professional situations. Its methodological value depends on the authenticity of educational tasks, the clarity of assessment criteria, and the quality of evidence supporting evaluative conclusions.

International frameworks, particularly the OECD PISA 2025 Science Framework and the UNESCO ICT Competency Framework for Teachers, offer useful conceptual resources for developing science-related and digital pedagogical assessment indicators. Nevertheless, these frameworks must be adapted to the specific requirements of professional teacher education.

The proposed conceptual assessment framework combines

authentic performance tasks, analytical rubrics, differentiated competency indicators, and reflective feedback. Its principal contribution is the theoretical organization of assessment procedures around observable professional competence rather than the reproduction of subject knowledge alone.

Further empirical research is required to establish the validity, reliability, and practical effectiveness of the proposed methodology in higher pedagogical education institutions.

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