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Research on the Optimization of Junior High School Physics Experiment Teaching from the Perspective of Teaching-Learning-Assessment Consistency

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Abstract: This paper clarifies the fundamental connotation of the Teaching-Learning-Assessment Consistency framework and explores its critical alignment with junior high school physics experiment teaching. In the current educational landscape, traditional experiment teaching often suffers from significant defects, including a disconnect between theoretical instruction and practical application, inadequate student engagement, and fragmented evaluation methods that fail to capture comprehensive learning outcomes. Targeting these inherent limitations, this study proposes systematic and comprehensive optimization strategies structured across three primary dimensions. First, it emphasizes curriculum standard-oriented teaching objective decomposition, ensuring that every experimental activity is directly anchored to overarching educational goals. Second, it advocates for diversified experimental activity design, which incorporates inquiry-based learning, collaborative projects, and hands-on problem-solving to stimulate student interest and active participation. Third, it details the construction of a multi-dimensional evaluation system that continuously monitors student progress through formative and summative assessments, thereby closing the feedback loop between teaching and learning. The proposed practice framework can effectively improve overall teaching efficiency, bridge the gap between theoretical knowledge and practical execution, and cultivate students' core competencies in physics, such as critical thinking, scientific inquiry, and analytical reasoning. Ultimately, this research provides a robust theoretical foundation and a highly actionable reference for advancing physics experiment teaching reform under the rigorous demands of the new curriculum standards.

Keywords: educational consistency; physics education; experiment teaching; teaching strategies; evaluation system; curriculum reform

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1. Introduction

With the progressive development of modern educational theories, the integration of the Teaching-Learning-Assessment Consistency concept into physics education has emerged as a transformative approach to enhance the effectiveness of classroom instruction, particularly in the context of physics experiments. This concept emphasizes the alignment of teaching methods, learning activities, and assessment strategies to create a cohesive and comprehensive educational experience. By applying this framework, educators can refine the structure and delivery of physics experiment lessons, thereby fostering a more engaging and interactive learning environment [1]. Such optimization not only enhances the overall quality of teaching but also supports the cultivation of essential physics competencies among students. Experiment-based teaching occupies a central role in the junior high school physics curriculum, serving as a pivotal mechanism to ignite students' curiosity and enthusiasm for physics. Through hands-on experimentation, students are encouraged to develop critical skills such as problem identification, evidence evaluation, and the ability to articulate scientific explanations and

communicate findings effectively. These foundational skills are instrumental in nurturing scientific thinking and facilitating the construction of robust physics concepts. Furthermore, experiment teaching provides students with opportunities to explore real-world phenomena, enabling them to connect theoretical knowledge with practical applications. This approach lays the groundwork for a deeper understanding of scientific principles and fosters a lifelong appreciation for the discipline of physics.

The effective integration of the Teaching-Learning-Assessment Consistency concept into junior high school physics experiment teaching represents a significant advancement in educational practice. By ensuring that teaching objectives, learning activities, and assessment methods are harmonized, educators can create a more streamlined and impactful learning process. This alignment not only addresses the requirements set forth by contemporary curriculum standards but also enhances the efficiency of instructional delivery. As a result, students are better equipped to develop core competencies in physics, including analytical thinking, problem-solving, and the ability to apply scientific knowledge in diverse contexts. The application of this concept also encourages educators to adopt innovative teaching strategies, such as inquiry-based learning and collaborative problem-solving, which further enrich the educational experience. Moreover, the emphasis on consistency across teaching, learning, and assessment processes ensures that students receive a balanced and comprehensive education, enabling them to achieve a deeper understanding of physics concepts. This approach ultimately contributes to the development of well-rounded individuals who possess the skills and knowledge necessary to excel in scientific pursuits and beyond.

2. Overview of Teaching-Learning-Assessment Consistency

In the context of junior high school physics experiment teaching, Teaching-Learning-Assessment Consistency refers to a systematic approach where educators align teaching objectives, learning activities, and assessment methods to ensure a cohesive educational experience. Teachers begin by establishing clear, specific, and actionable teaching objectives that serve as the foundation for the entire instructional process. These objectives are designed to be both measurable and achievable, ensuring that students can progressively master physics concepts and experimental skills. Through the "teaching" phase, educators introduce theoretical knowledge and practical techniques, creating a structured framework that guides students in understanding the principles of physics. During the "learning" phase, students actively engage with the material, applying their knowledge in hands-on experiments to reinforce their understanding and develop critical thinking skills [2]. This phase emphasizes experiential learning, encouraging students to explore, hypothesize, and test their ideas in a controlled environment. Finally, the "assessment" phase plays a pivotal role in identifying gaps in students' understanding and evaluating their progress. By employing diverse assessment methods, such as performance evaluations, practical tests, and analytical reviews, educators can pinpoint areas requiring improvement and adapt their teaching strategies accordingly. This cyclical process ensures that teaching, learning, and assessment are interconnected, fostering a dynamic and responsive educational environment that supports student growth and achievement.

The formulation of teaching objectives is the cornerstone of achieving Teaching-Learning-Assessment Consistency, as it provides a clear direction and framework for instructional activities. These objectives should be meticulously crafted to align with the curriculum standards and the developmental needs of students, ensuring that they are both challenging and attainable. Teaching activities must revolve around these objectives, incorporating a variety of experimental designs to stimulate student interest and promote active participation. For instance, educators can encourage students to independently design inquiry-based experiments, fostering creativity and problem-solving skills. This approach not only enhances students' understanding of physics concepts but also equips them with practical skills that are essential for scientific exploration. The assessment system, integral to this process, should be multifaceted and tailored to evaluate various

aspects of student performance. Key areas of focus include the ability to design experimental schemes, execute procedures accurately, and analyze data effectively [3]. By aligning assessments with the experimental teaching process, educators can obtain valuable insights into student progress and areas for improvement. This feedback loop enables teachers to refine their instructional methods and provides students with targeted guidance to enhance their learning outcomes. Ultimately, the integration of teaching objectives, diverse instructional strategies, and comprehensive assessments creates a cohesive framework that supports continuous improvement in physics education.

3. Teaching Strategies for Junior High School Physics Experiment under the Concept of Teaching-Learning-Assessment Consistency

The concept of Teaching-Learning-Assessment Consistency underscores the seamless integration of teaching, learning, and assessment processes to enhance educational outcomes. This approach advocates for a cohesive framework where each component complements the others, ensuring that instructional strategies align with learning objectives and assessment methods. Teachers are encouraged to tailor their teaching practices to the specific content being delivered, selecting strategies that best facilitate student understanding and engagement. By systematically implementing each stage of the teaching process, educators can create a dynamic and interactive learning environment that fosters deeper comprehension and skill acquisition. Figure 1 illustrates the proposed flowchart for teaching practice under this concept, serving as a visual guide for educators to structure their lessons effectively. This model emphasizes the importance of adaptability and responsiveness in teaching, urging instructors to continuously refine their methods based on student feedback and performance metrics. Furthermore, the integration of assessment as a core component ensures that learning outcomes are consistently monitored and evaluated, enabling teachers to identify areas for improvement and adjust their strategies accordingly. By adopting this holistic approach, educators can bridge the gap between theoretical knowledge and practical application, equipping students with the tools they need to succeed in physics experiments and beyond. The emphasis on consistency across teaching, learning, and assessment not only enhances the quality of education but also promotes a more equitable and inclusive learning experience for all students.

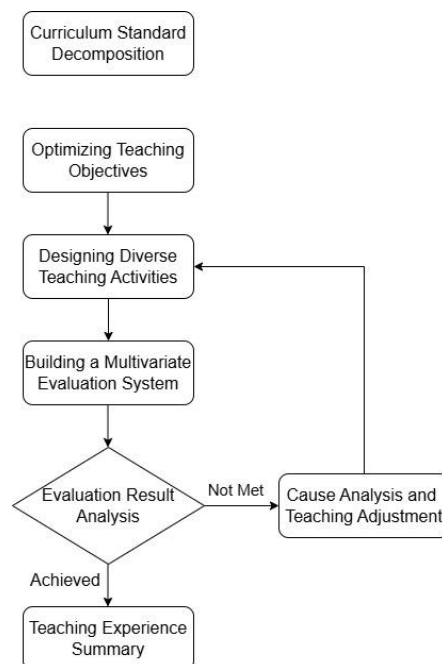


Figure 1. Flowchart of teaching practice based on Teaching-Learning-Assessment Consistency

3.1. *Decompose Teaching Objectives Oriented by the New Curriculum Standard*

The physics curriculum standards outline comprehensive and detailed requirements for establishing a Teaching-Learning-Assessment Consistency classroom in junior high school physics experiment teaching. These standards serve as the foundation and guiding framework for teaching activities. To effectively implement these standards, teachers must thoroughly analyze the new curriculum guidelines, identify key teaching requirements based on the core competencies of physics, and design scientifically sound teaching objectives tailored to students at different developmental stages. By doing so, educators can provide structured guidance that enables students to enhance their overall physics proficiency. Furthermore, aligning teaching objectives with the curriculum standards ensures that students not only acquire knowledge but also develop critical thinking, problem-solving skills, and a deeper understanding of physical phenomena. This approach fosters a holistic learning environment where students are encouraged to explore, question, and apply their knowledge in meaningful ways, ultimately contributing to their academic growth and personal development [4].

For instance, consider the experiment on Exploring the Imaging Characteristics of Plane Mirrors. In this activity, students build upon their prior knowledge of the linear propagation of light and the principles of light reflection. They are introduced to the characteristics, principles, and practical applications of plane mirror imaging [5]. Teachers can establish specific teaching objectives to guide this learning process. Through inquiry-based activities, students can gain an understanding of the imaging characteristics of plane mirrors, which helps cultivate their observational skills and hands-on operational abilities. Additionally, students can explore the laws governing plane mirror imaging and practice drawing optical path diagrams, which enhances their analytical and visualization skills. Furthermore, by examining the applications of plane mirrors in everyday life, students develop their ability to exchange information and evaluate practical uses, fostering critical thinking and communication skills. These objectives not only address the acquisition of knowledge but also emphasize the development of students' abilities and emotional values, promoting their comprehensive and balanced growth. By integrating these elements into the teaching process, educators can create a dynamic and engaging learning environment that supports students in achieving their full potential academically and personally.

3.2. *Design Diversified Experimental Teaching Activities*

In the design of experimental teaching activities, teachers must align their efforts with the teaching objectives outlined in the new curriculum standards [6, 7]. Activities should be carefully crafted to ensure they are closely connected to these objectives, fostering a coherent and effective learning experience. By creating life-related and intuitive scenarios, educators can make abstract physics concepts more accessible and relatable. Employing flexible and diverse experimental methods allows students to engage deeply with complex ideas, encouraging hands-on participation. This approach not only aids in the comprehension of scientific principles but also supports the development of students' core competencies through active scientific reasoning and inquiry.

Creating scenarios to drive experimental inquiry is particularly important for junior high school students, who are at a pivotal stage in their cognitive and intellectual development. Each student possesses a unique learning style, set of interests, and cognitive abilities, which necessitates a tailored and effective teaching approach. To help students overcome the challenges of understanding difficult physics concepts, teachers should ensure alignment between teaching, learning, and assessment. Introducing course content through vivid and relatable scenarios can make physics more engaging and less intimidating. By positioning students as active participants in the learning process, educators can bridge the gap between abstract physics knowledge and real-life applications. This strategy not only simplifies complex topics but also enhances students' familiarity and comfort with the subject matter.

For instance, in the lesson on Exploring Friction and the Relationship Between Fluid Pressure and Flow Velocity, teachers can introduce the topic using everyday life scenarios. Examples such as the placement of safety lines on railway platforms or the lift generated by aircraft wings can demonstrate the relevance of physics in daily life [8, 9]. These relatable contexts can ignite students' enthusiasm for learning, helping them connect physical principles to common phenomena and technological advancements. Through experimental inquiry, students can gain a deeper understanding of these principles, fostering both curiosity and comprehension.

The integration of diversified experimental forms is essential to modernizing physics education. Traditional methods often rely on a single experimental approach, which can limit students' engagement and understanding [10, 11]. To ensure consistency between teaching, learning, and assessment in junior high school physics, educators must move beyond the constraints of exam-oriented education. By incorporating a variety of experimental formats—such as inquiry-based experiments, group activities, and digital experiments—teachers can tailor their methods to different learning objectives. This diversity enables students to develop critical skills, including problem identification, analysis, and resolution, through practical application. Such an approach shifts the focus from passive knowledge acquisition to active inquiry-based learning, fostering a more dynamic and effective educational experience.

In the experiment on Exploring the Law of Current in Series and Parallel Circuits, teachers can design inquiry-based activities to stimulate students' scientific thinking. For example, students might begin by observing the varying brightness of two bulbs, which could prompt them to hypothesize about the underlying principles. By designing and using an ammeter to measure the current at different points in circuits containing two or three bulbs, students can explore the general laws governing current flow. This progression from specific observations to general principles helps students establish a solid foundation in physics concepts. Additionally, it reinforces proper experimental techniques and encourages the use of inquiry-based methods to solve physics problems, promoting a deeper and more structured understanding of the subject.

Group experiments play a crucial role in creating immersive inquiry-based learning environments. These activities are designed to enhance students' practical skills, teamwork abilities, and scientific problem-solving competencies. For example, in the experiment on Measuring the Density of Substances, teachers can provide each group with essential tools such as balances, measuring cylinders, and samples of solids and liquids. During the activity, students apply the density calculation formula to determine the densities of various materials. Through collaborative efforts and iterative optimization of their experimental approaches, students not only refine their technical skills but also develop important scientific literacies, such as effective communication and collaborative inquiry. This hands-on, team-based approach fosters a comprehensive understanding of experimental processes and outcomes.

The new curriculum standards advocate for the use of digital experimental instruments in schools that have the necessary resources. By leveraging information technologies such as multimedia tools and virtual experiments, educators can enrich the content and format of their lessons. Digital experiments offer several advantages, including the visualization and intelligent analysis of traditional experimental processes. These tools enable real-time recording and analysis of experimental data, significantly enhancing the overall teaching and learning experience. By incorporating digital technologies, teachers can make experiments more engaging and accessible, ultimately improving the effectiveness of physics education [3, 12].

Consider the experimental teaching of Exploring the Internal Pressure of Liquid [13]. Traditional liquid pressure gauges often lack precision and fail to account for factors such as atmospheric pressure, leading to incomplete or inaccurate results. By utilizing a Digital Experiment System (DIS) equipped with pressure sensors, data recorders, and other advanced tools, teachers can measure liquid pressure in real time. This approach allows students to investigate the qualitative relationships between liquid pressure, depth, and

density with greater accuracy and efficiency. Compared to traditional methods, digital experiments reduce operational difficulties and eliminate common sources of error, such as inaccuracies in liquid pressure gauges. This not only deepens students' understanding of liquid pressure but also helps them achieve the broader objectives of experimental teaching by fostering analytical and technical skills.

3.3. Construct a Diversified Evaluation System to Ensure the Consistency between Evaluation and Objectives

In junior high school physics experiment classrooms, constructing a scientific and systematic evaluation system is essential for accurately understanding teaching dynamics and monitoring students' learning progress. Traditional physics experiment teaching often relies solely on examination results as the primary standard for evaluation. This singular approach is overly simplistic and fails to support the optimization of teaching methods or the holistic development of students. To address these limitations, teachers should establish a diversified teaching evaluation framework that integrates evaluation into every stage of the physics experiment teaching process. This approach ensures that the evaluation aligns with the broader educational objectives and fosters a more comprehensive understanding of student performance.

Teachers can combine formative assessment with summative assessment to create a balanced and comprehensive evaluation system. This dual approach allows for a thorough analysis of both process performance and result effectiveness. By doing so, teachers can gather timely feedback on teaching practices, enabling them to dynamically refine their strategies. This iterative process supports the creation of a student-centered, high-efficiency classroom environment where teaching, learning, and assessment are seamlessly integrated. Such a system not only enhances the quality of instruction but also ensures that students are actively engaged in their learning journey, fostering deeper understanding and skill development.

Formative assessment emphasizes students' active participation and collaborative efforts during classroom activities. Teachers can evaluate students' engagement and teamwork by observing their specific actions and contributions at each stage of the experiment. This method of evaluation helps students identify their weaknesses promptly, allowing them to adjust their learning strategies accordingly. For teachers, formative assessment provides valuable insights into the effectiveness of their instructional design, enabling them to make necessary adjustments to better meet the needs of their students [14]. By focusing on the process rather than just the outcome, formative assessment encourages continuous improvement and supports the development of critical thinking and problem-solving skills.

For instance, in the experiment "Exploring the Equilibrium Condition of Levers," students work collaboratively in groups to organize the experimental process. They engage in discussions to analyze questions such as "Why should the lever be balanced in the horizontal direction?" and present their findings through group speeches. This collaborative approach not only enhances their understanding of the equilibrium condition of levers but also develops their communication and teamwork skills. Teachers can conduct a dynamic and comprehensive evaluation based on their observations and the feedback from group presentations [15]. This method promotes the gradual enhancement of students' core competencies, including scientific reasoning, analytical thinking, and effective communication.

Summative assessment focuses on evaluating students' overall mastery of experimental knowledge through comprehensive tasks such as experiment reports. These reports require students to meticulously document the experimental process, analyze data, and draw conclusions. This practice not only strengthens their written communication skills but also enhances their ability to conduct scientific inquiries. Additionally, teachers can utilize tools such as physics workbooks, test papers, and classroom tests to perform quantitative evaluations [8]. These assessments provide a clear measure of students' knowledge acquisition and their ability to apply theoretical concepts in practical scenarios.

By combining these methods, summative assessment ensures a thorough evaluation of students' learning outcomes and supports their academic growth.

4. Conclusion and Prospect

The practical integration of the Teaching-Learning-Assessment Consistency concept encompasses three critical dimensions: teaching objectives, teaching activities, and teaching assessment. This framework provides a robust and systematic approach to enhancing junior high school physics experiment teaching. By aligning these dimensions, educators can ensure that the instructional process is coherent and targeted toward achieving optimal learning outcomes. The Teaching-Learning-Assessment Consistency concept can be deeply embedded throughout the entire teaching process, fostering a seamless connection between theoretical knowledge and practical application. This approach not only addresses the core principles of physics as a subject but also caters to the developmental needs of students, encouraging their intellectual growth and curiosity. Furthermore, the implementation of this framework has the potential to transform traditional teaching methodologies, paving the way for innovative and high-efficiency physics classrooms. Future research could explore the scalability of this framework across different educational levels and subjects, as well as its adaptability to diverse learning environments. Additionally, empirical studies could investigate the long-term impact of this approach on student performance, engagement, and critical thinking skills. By continuously refining and optimizing this model, educators can contribute to the evolution of science education, ensuring that it remains relevant and effective in meeting the demands of modern society. This systematic integration holds promise for fostering a generation of learners who are not only proficient in physics but also equipped with the skills necessary to navigate complex scientific challenges.

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